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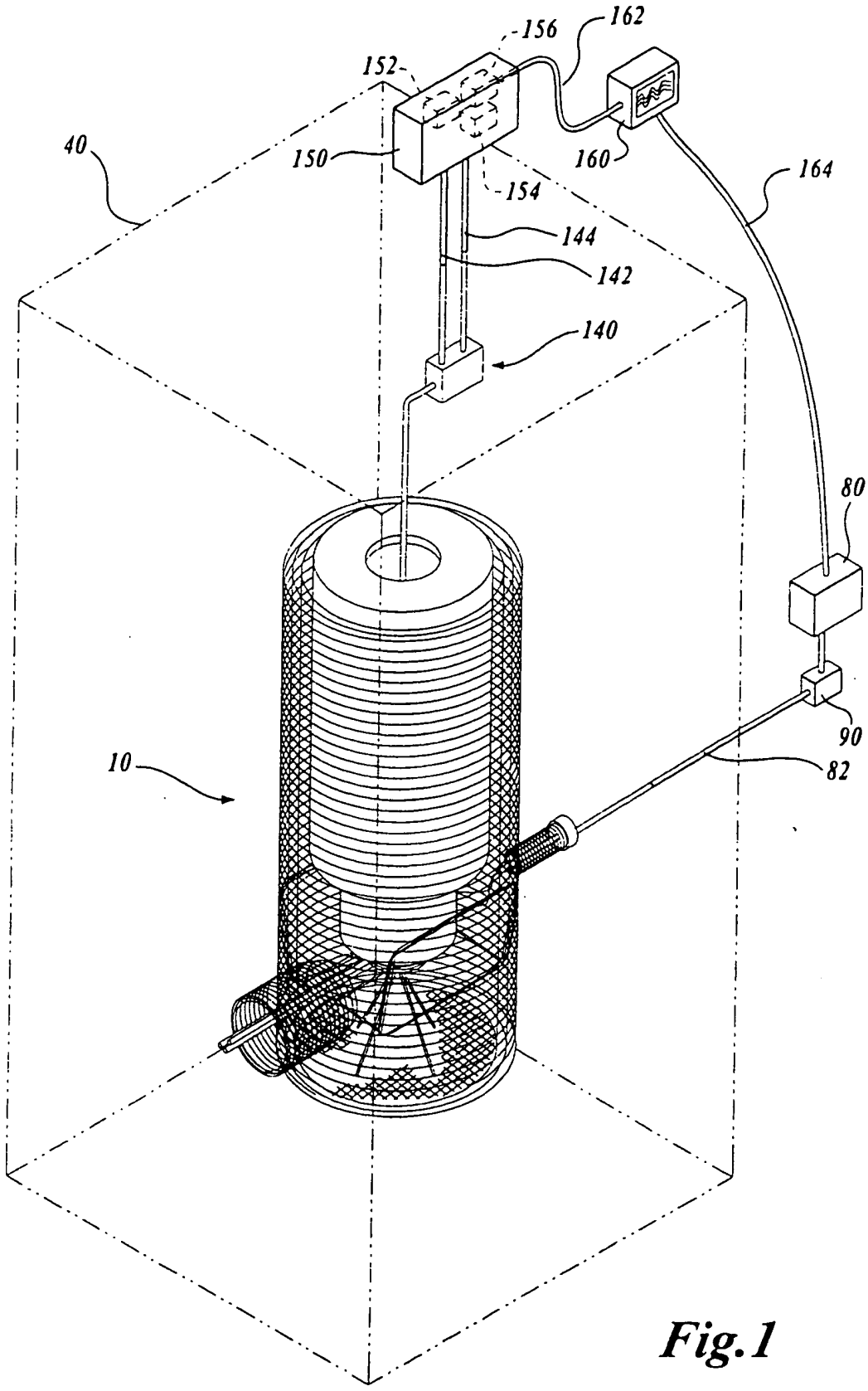


Fig.1

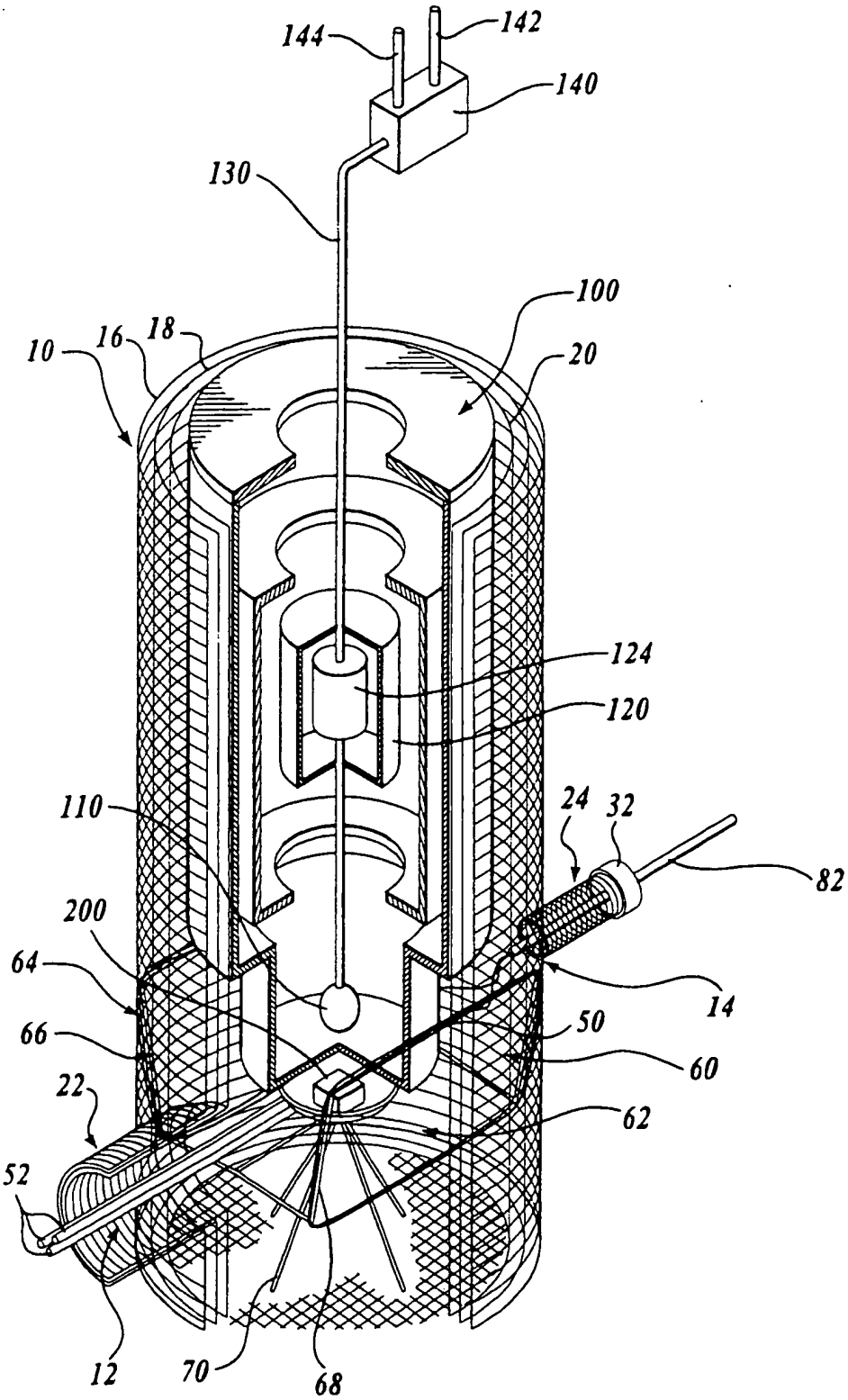

144
142
140
130
100
10
16
18
20
124
120
110
24
32
82
200
64
14
66
50
60
22
62
52
12
70
68

Fig.2

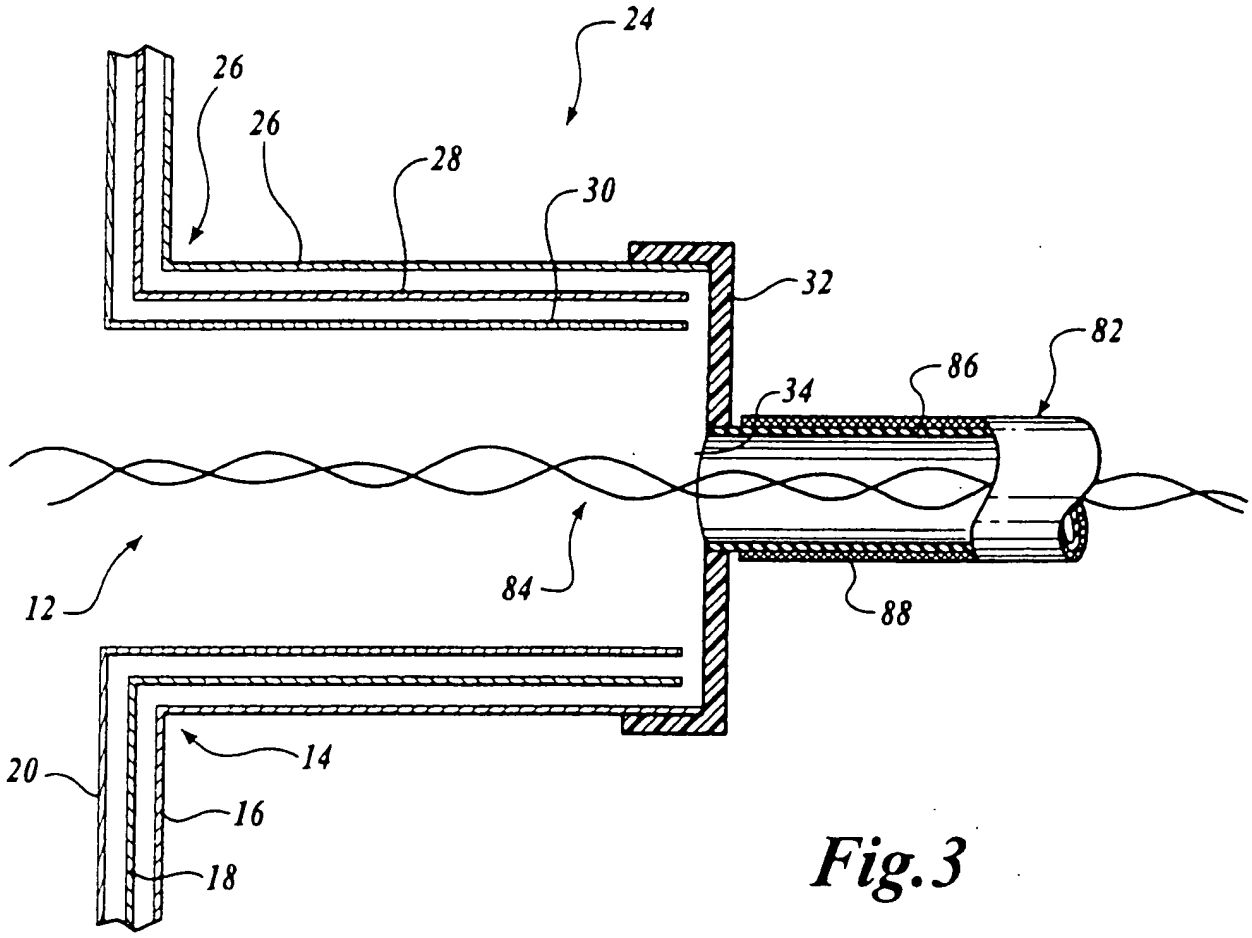


Fig.3

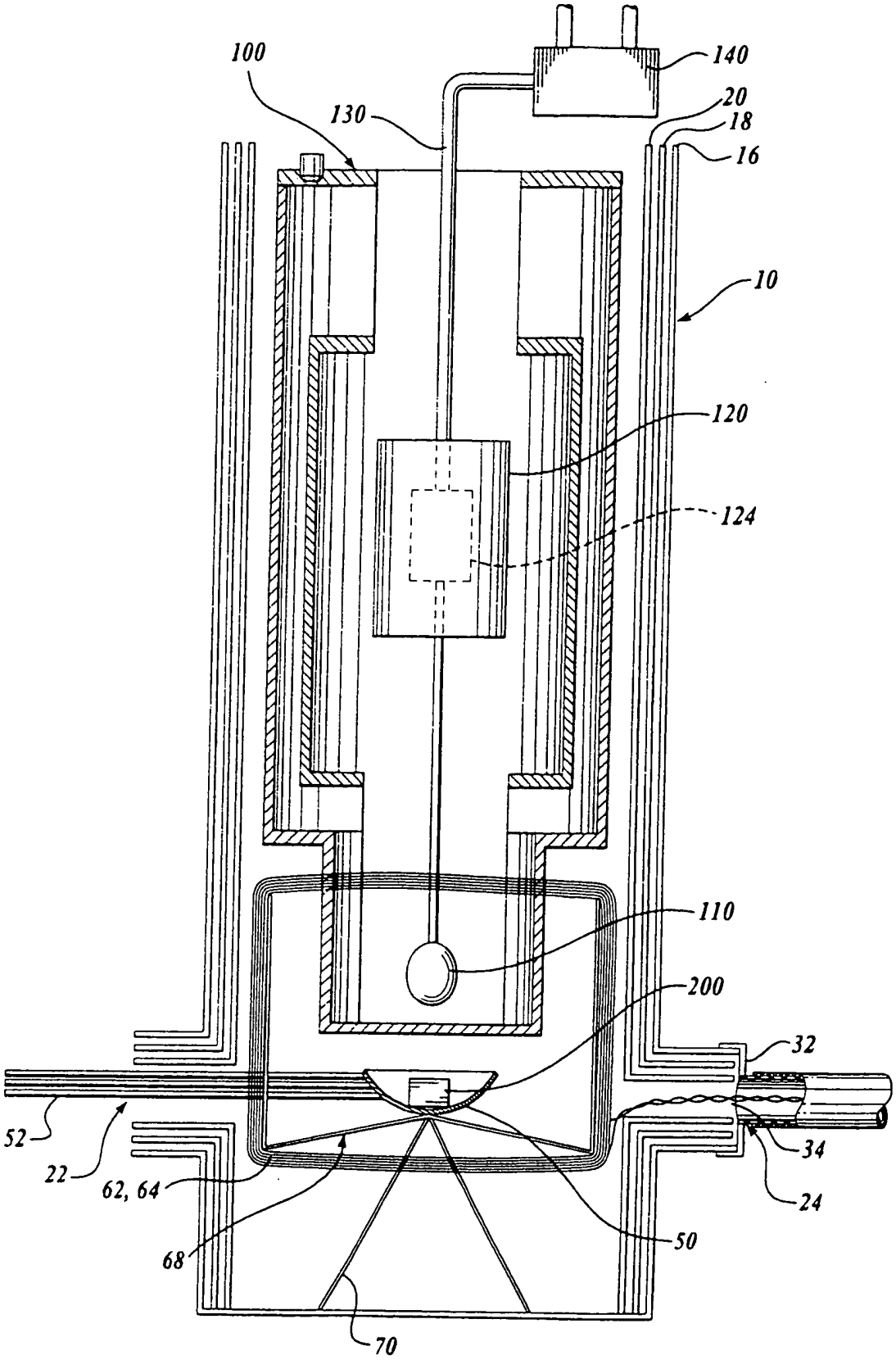


Fig.4

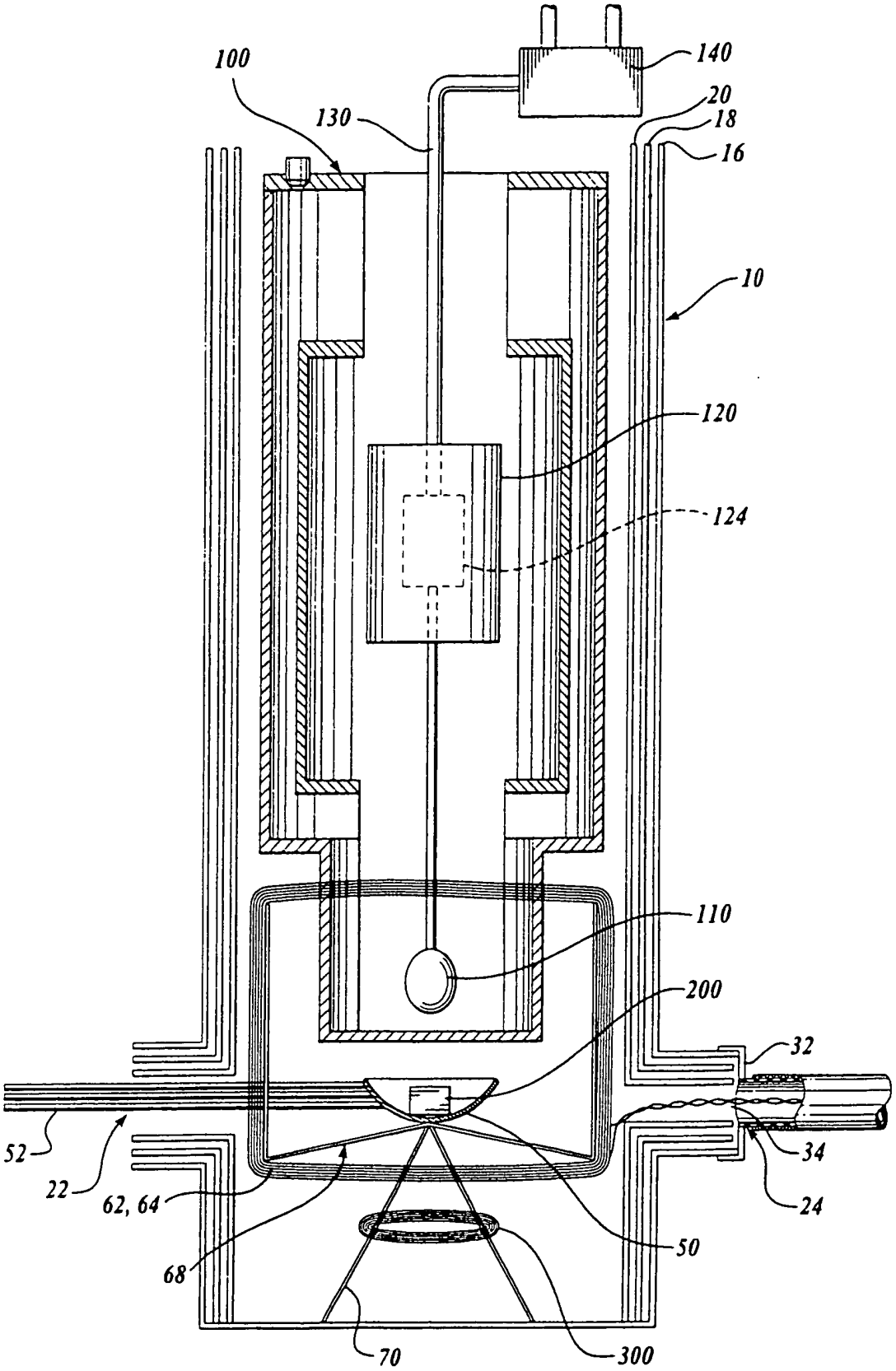
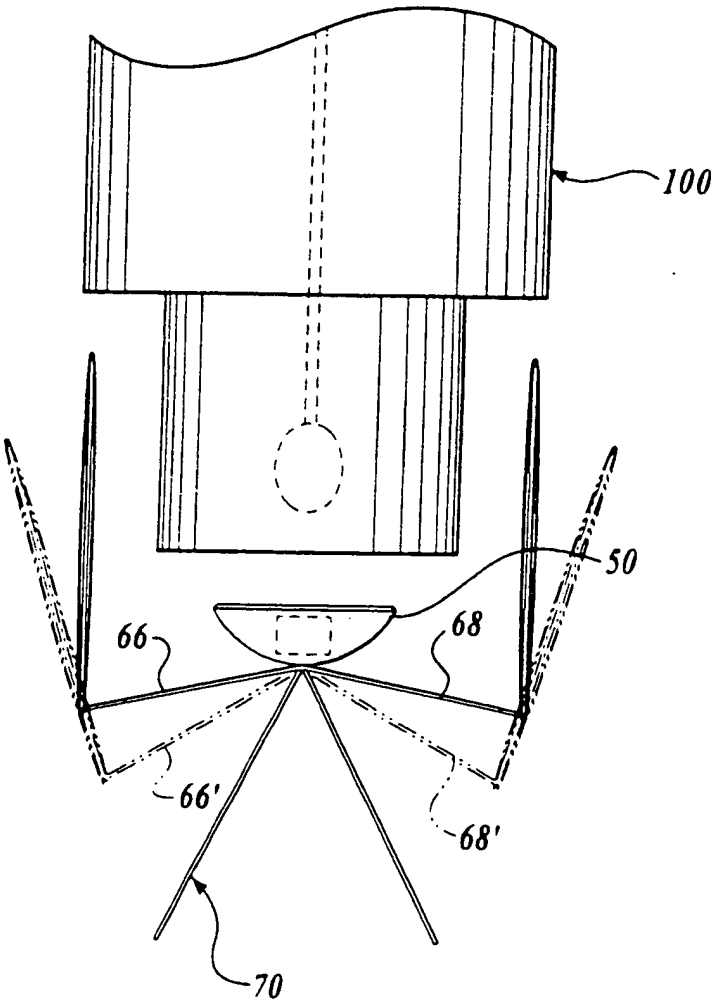

100
140
130
20
18
16
10
120
124
110
200
32
52
22
62, 64
34
24
50
68
70
300

Fig. 5

Fig.6



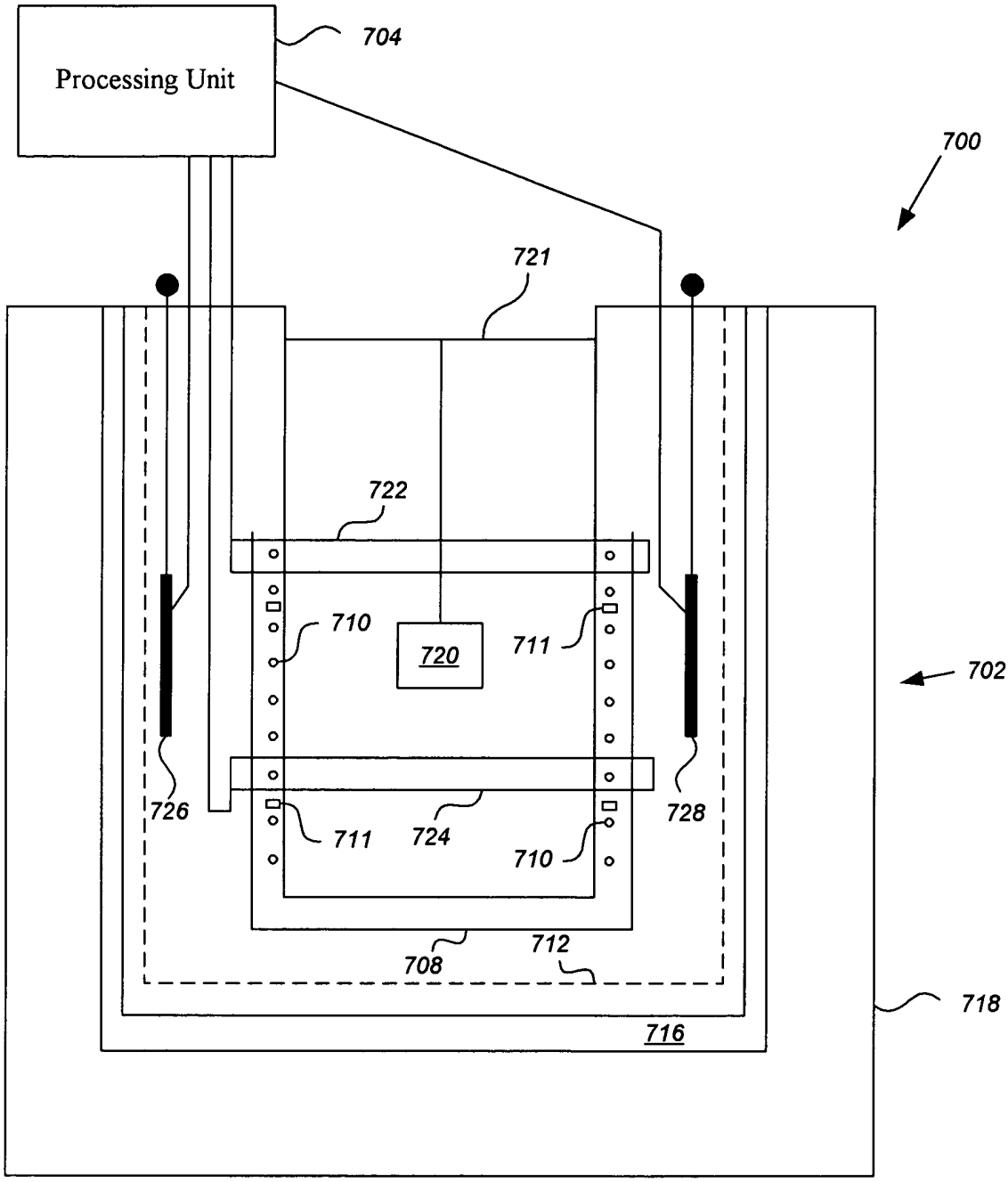

Processing Unit
704
700
721
722
710
720
711
702
726
728
711
724
710
712
708
718
716

FIG. 7

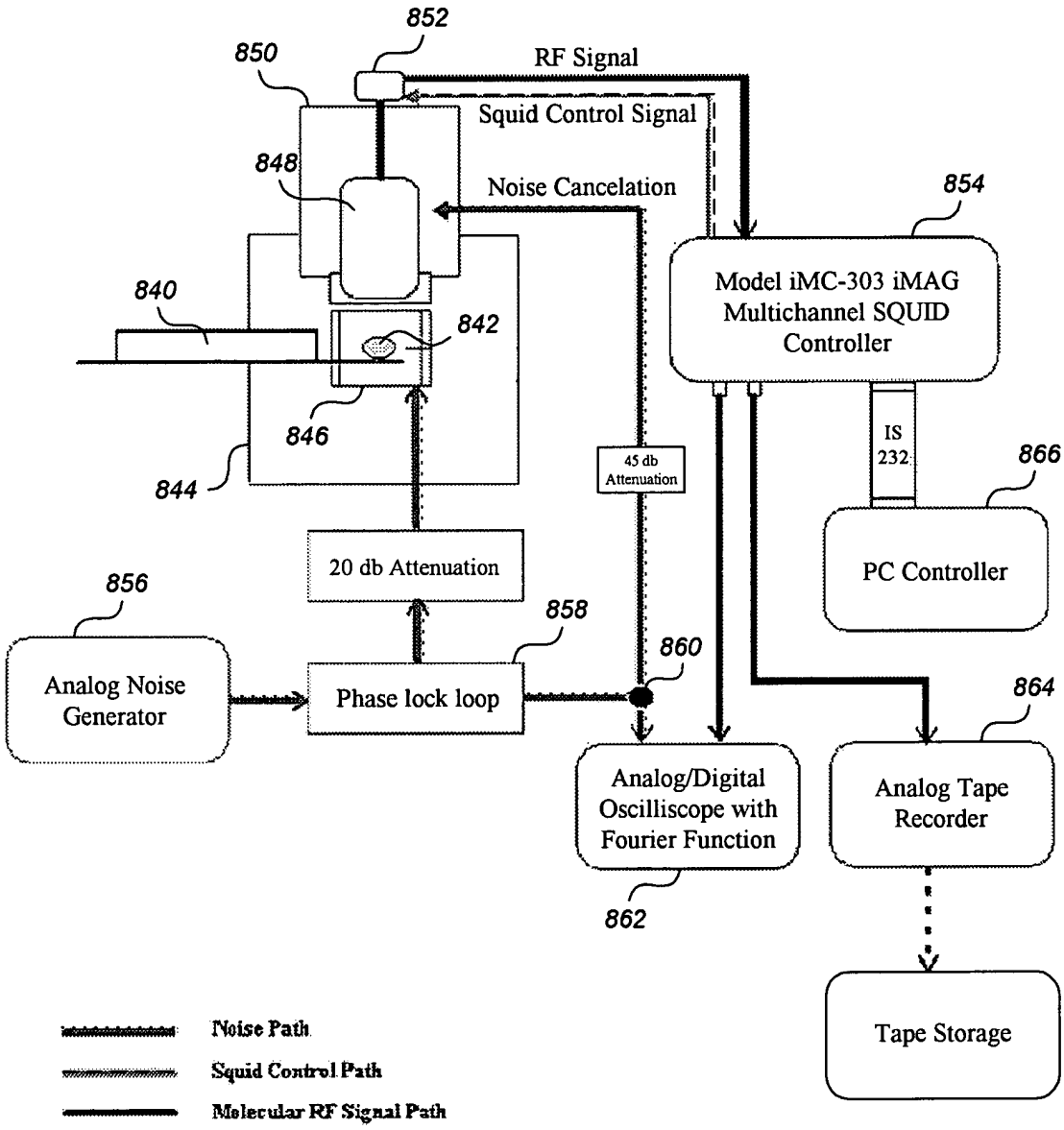

852
850
RF Signal
Squid Control Signal
848
Noise Cancelation
854
Model iMC-303 iMAG Multichannel SQUID Controller
840
842
846
844
45 db Attenuation
IS 232
866
PC Controller
20 db Attenuation
856
858
860
Analog Noise Generator
Phase lock loop
864
Analog/Digital Oscilliscope with Fourier Function
Analog Tape Recorder
862
Tape Storage
Noise Path
Squid Control Path
Molecular RF Signal Path

FIG. 8

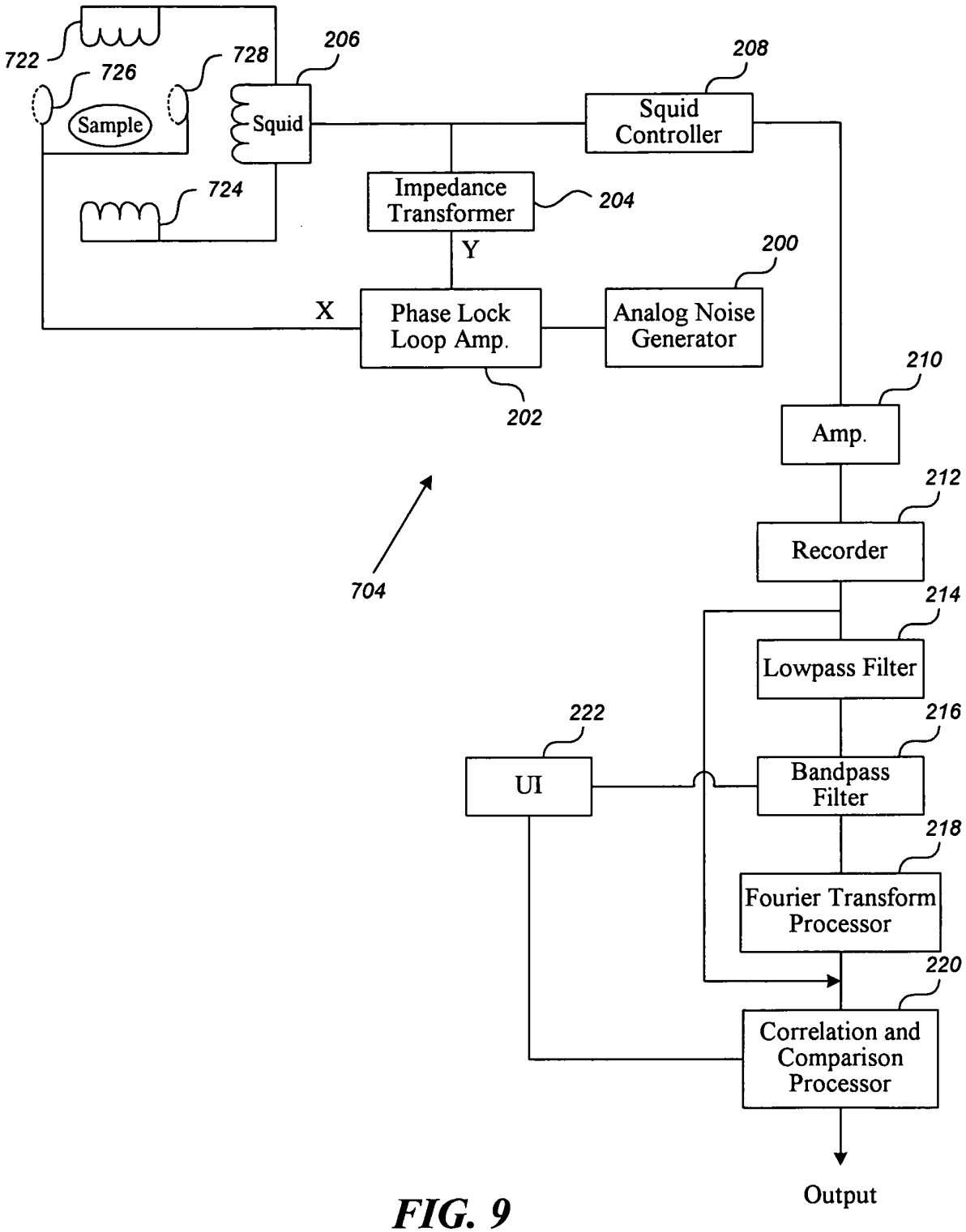

722
726
728
206
Sample
Squid
208
Squid Controller
724
Impedance Transformer
204
Y
200
X
Phase Lock Loop Amp.
Analog Noise Generator
202
210
Amp.
704
212
Recorder
214
Lowpass Filter
222
216
UI
Bandpass Filter
218
Fourier Transform Processor
220
Correlation and Comparison Processor
Output

FIG. 9

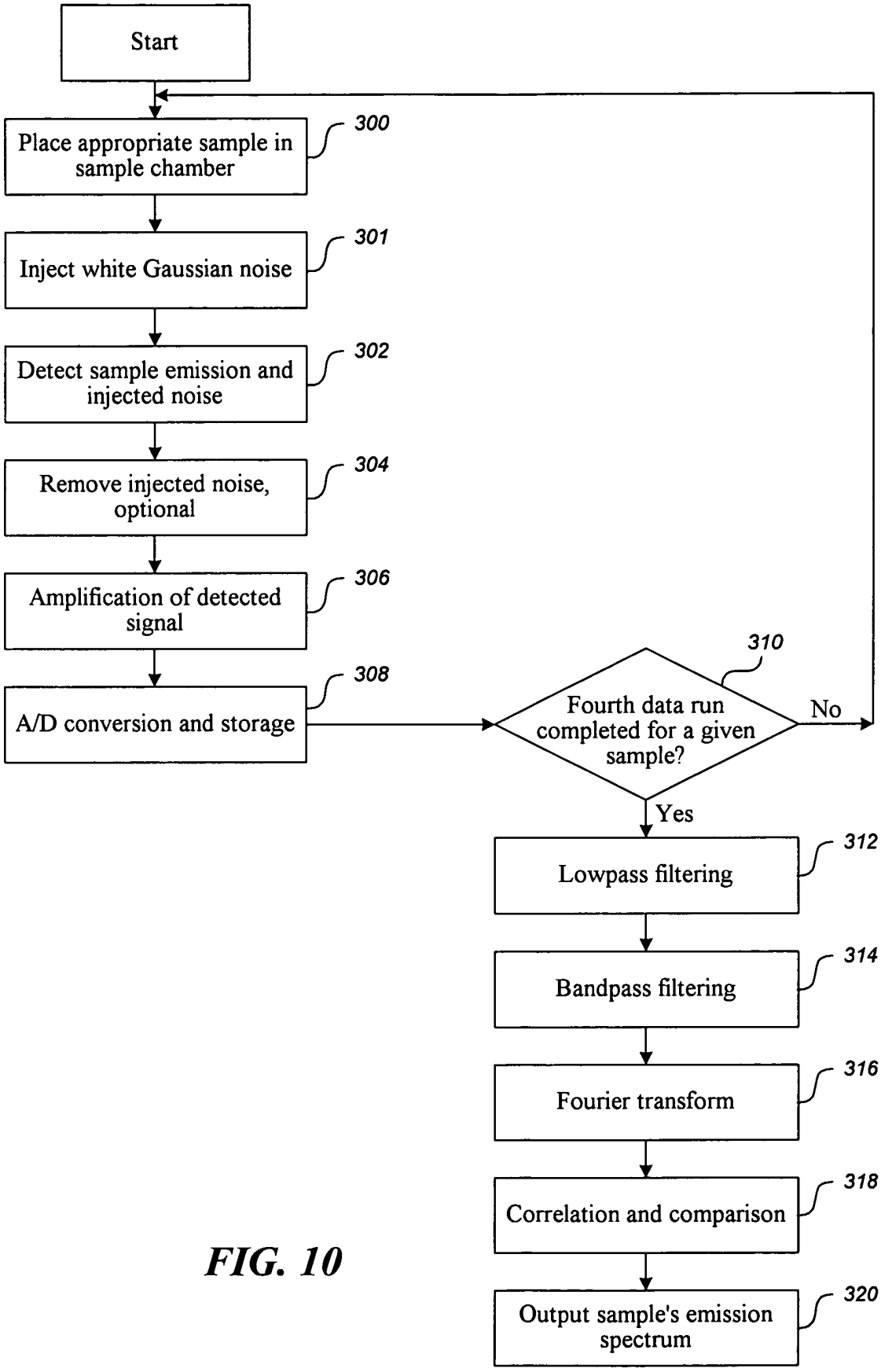

Start
Place appropriate sample in sample chamber
300
Inject white Gaussian noise
301
Detect sample emission and injected noise
302
Remove injected noise, optional
304
Amplification of detected signal
306
A/D conversion and storage
308
Fourth data run completed for a given sample?
310
No
Yes
Lowpass filtering
312
Bandpass filtering
314
Fourier transform
316
Correlation and comparison
318
Output sample's emission spectrum
320

FIG. 10

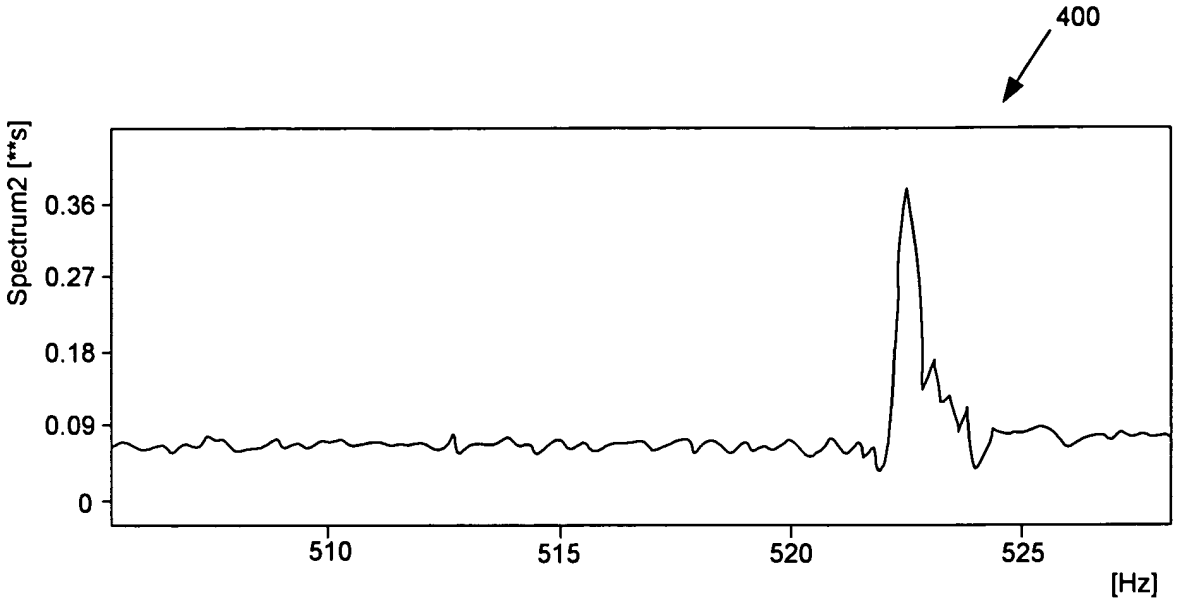


FIG. 11A

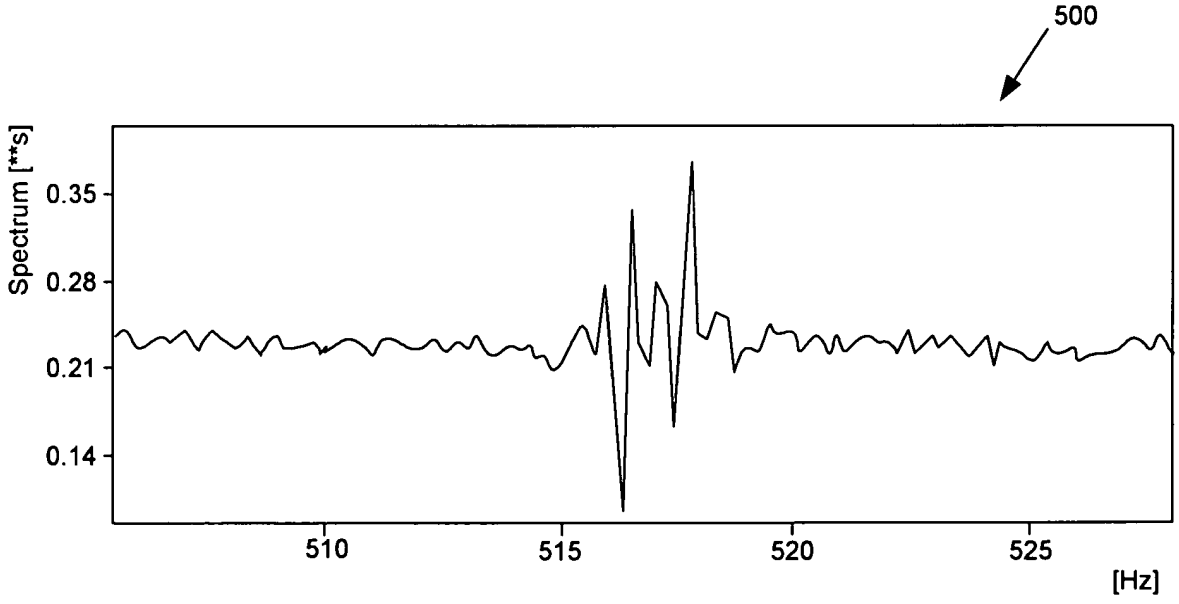


FIG. 11B

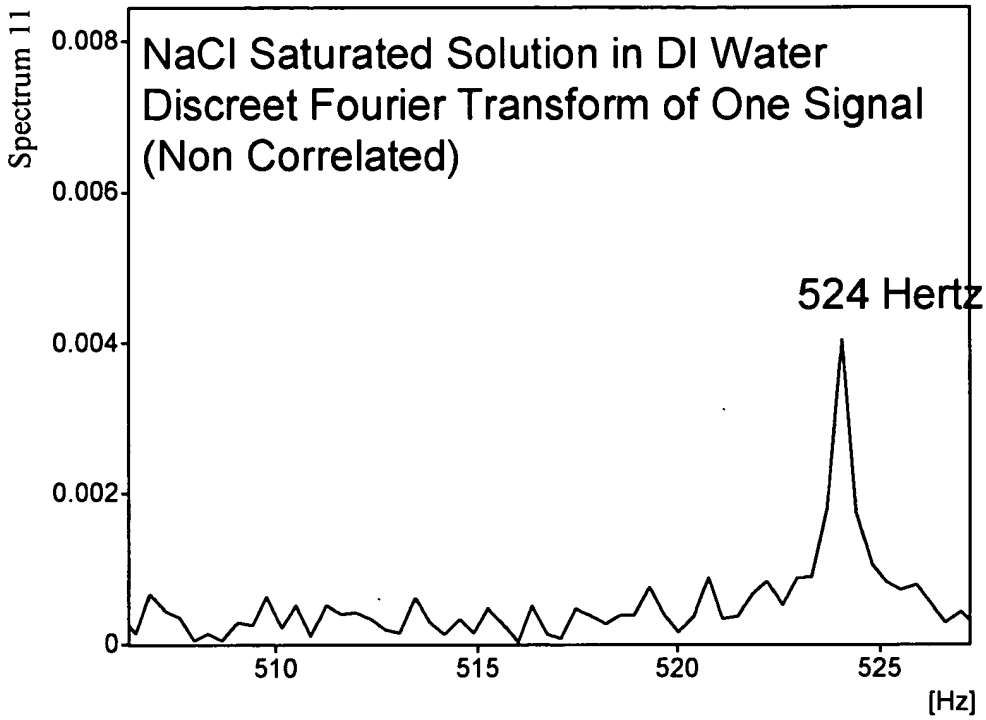


FIG. 12A

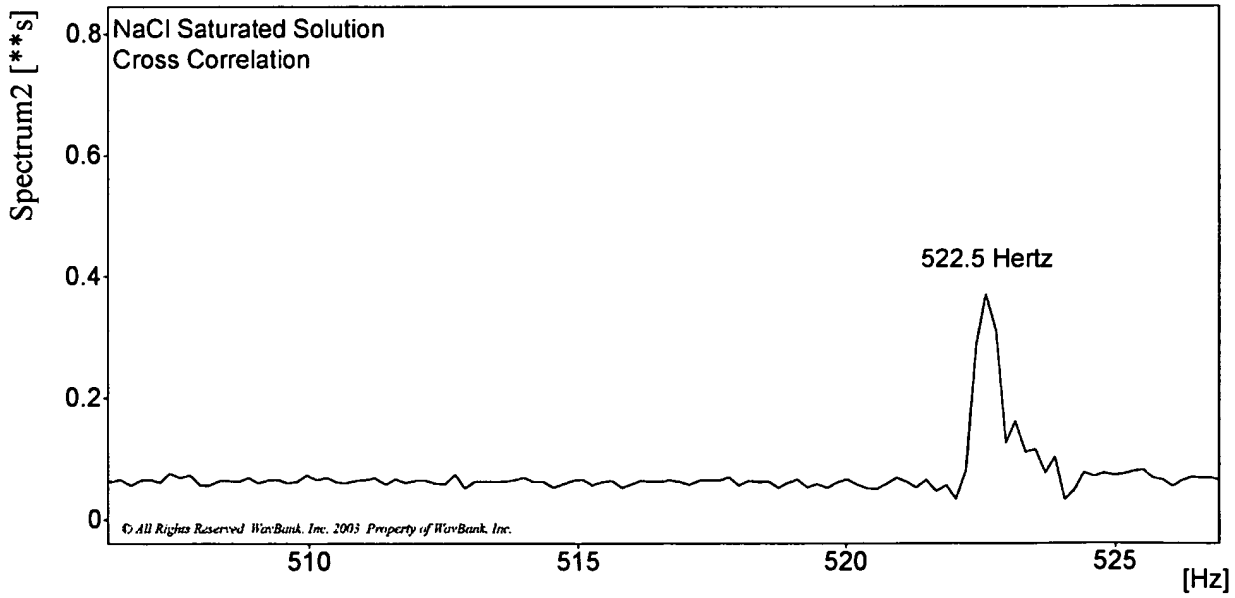


FIG. 12B

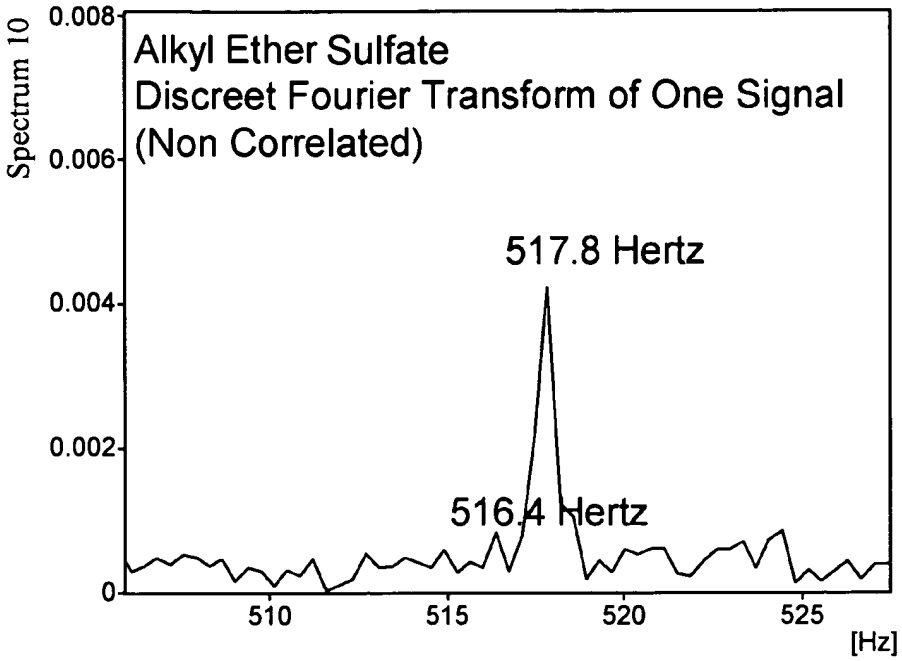


FIG. 13A

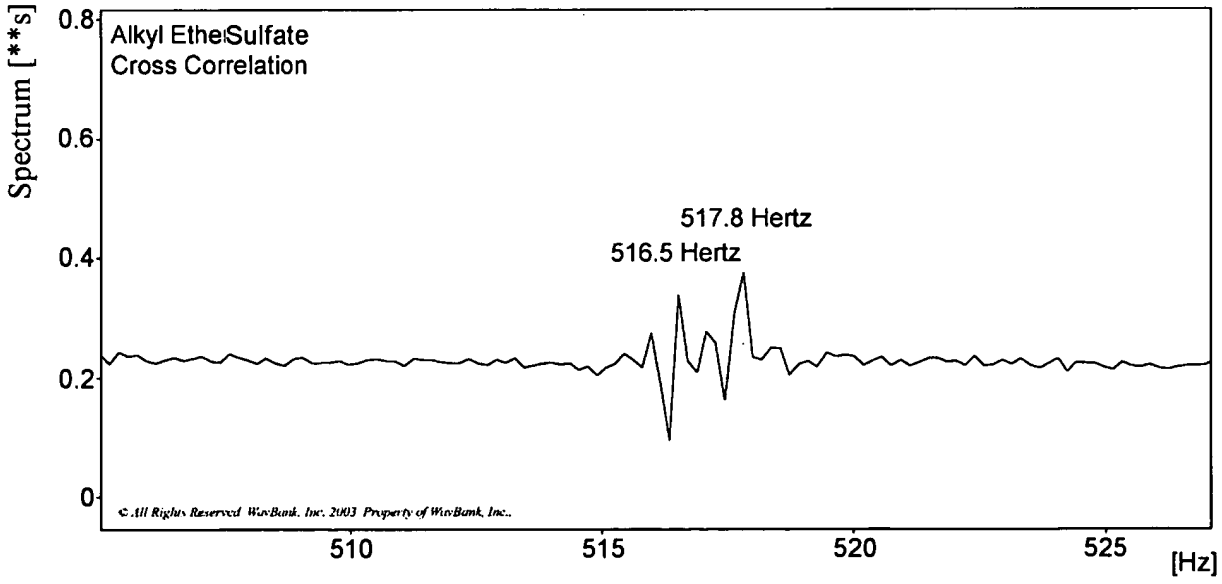


FIG. 13B

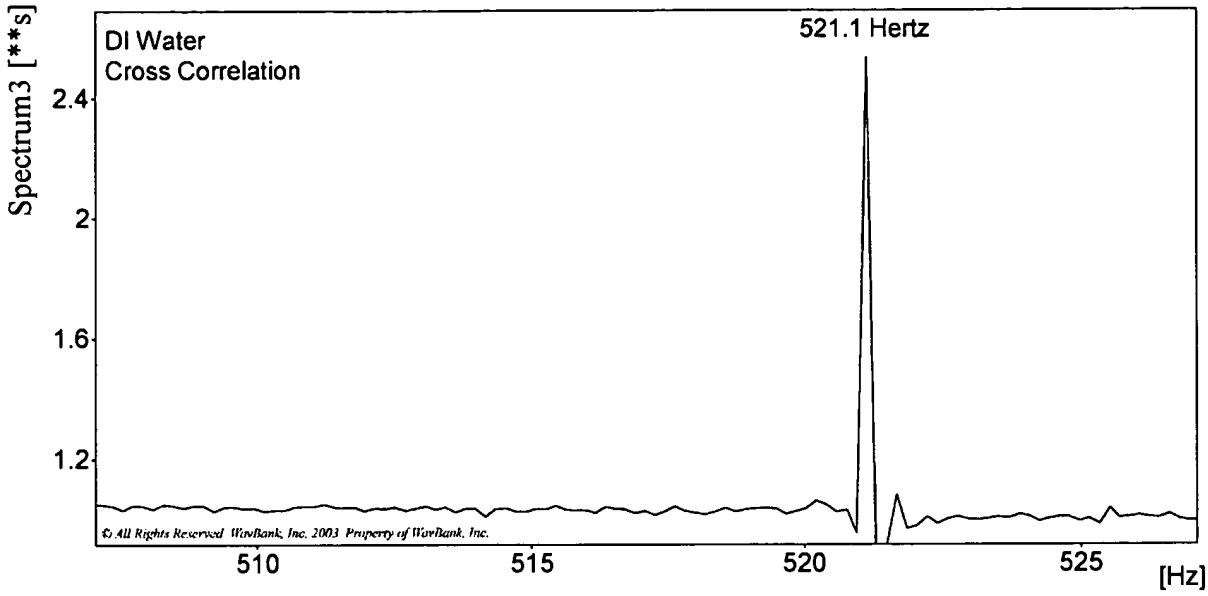


FIG. 14A

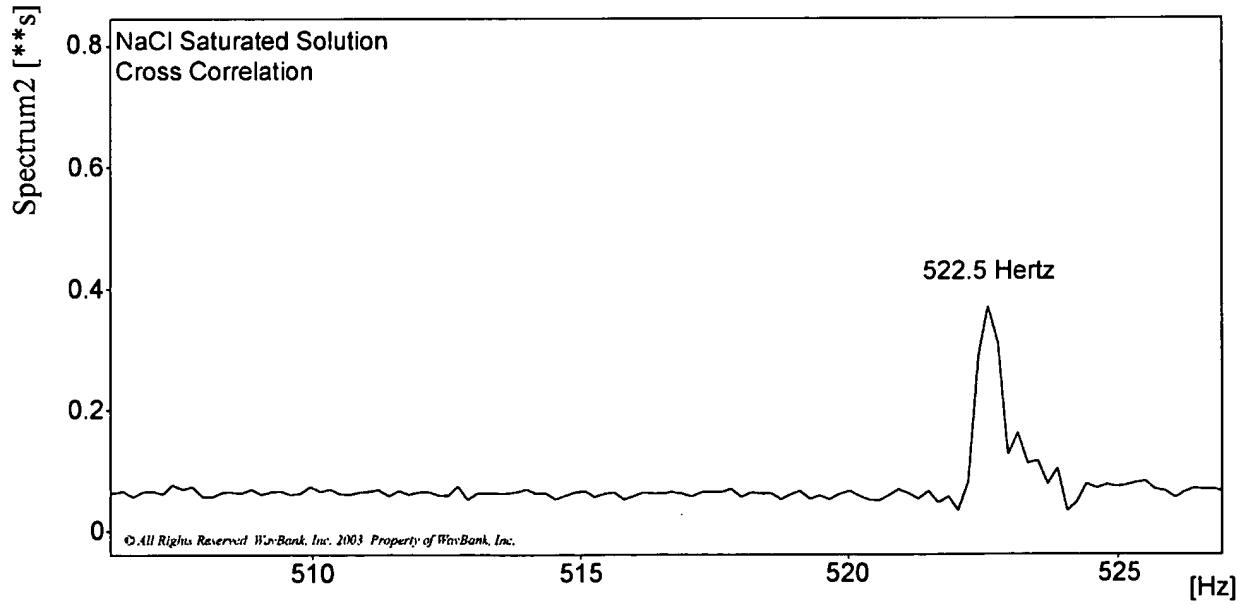


FIG. 14B

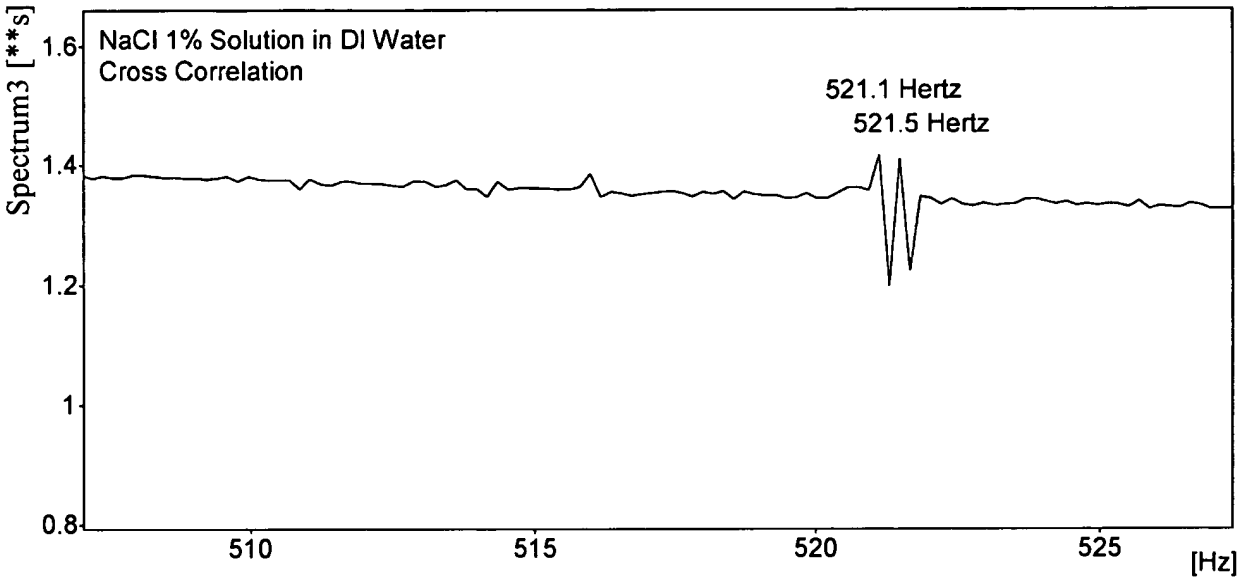


FIG. 14C

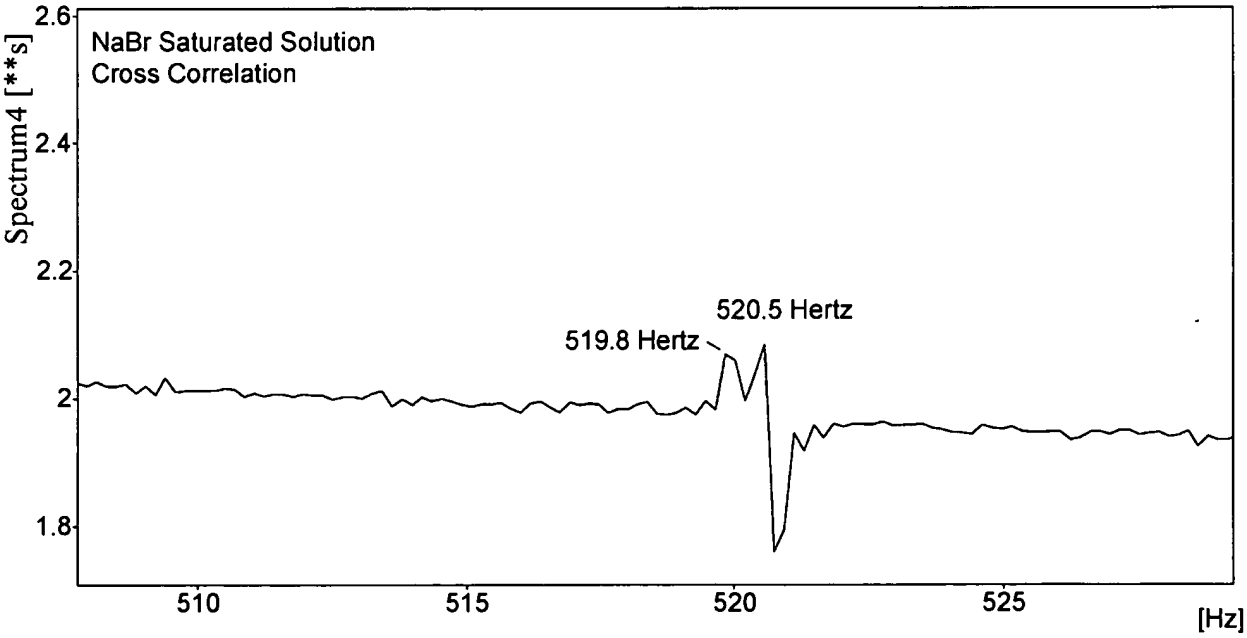


FIG. 14D

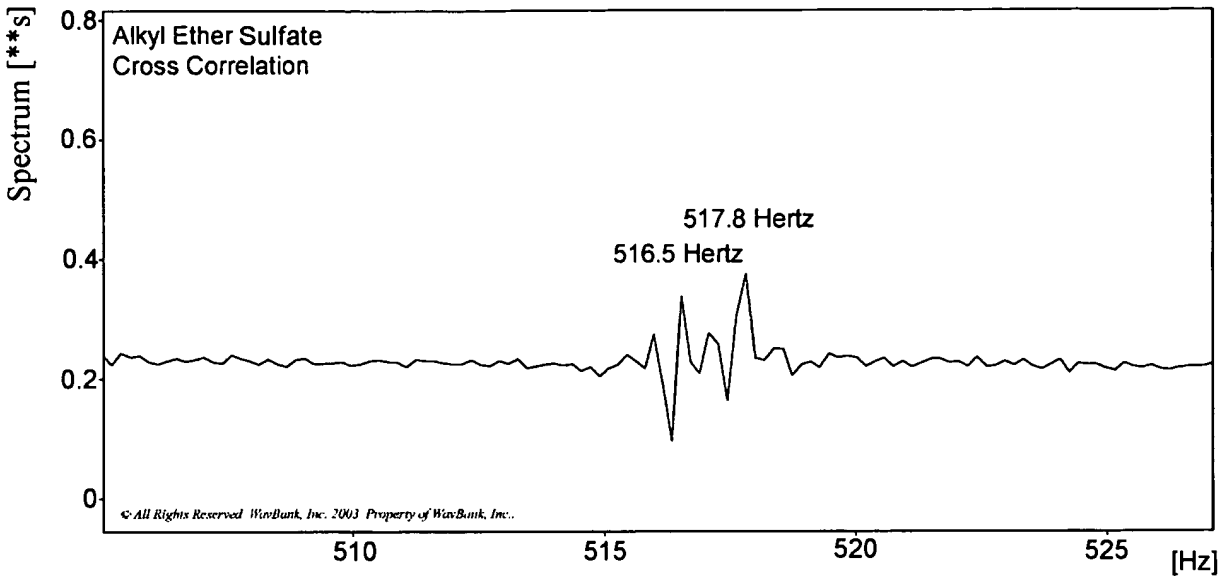


FIG. 14E

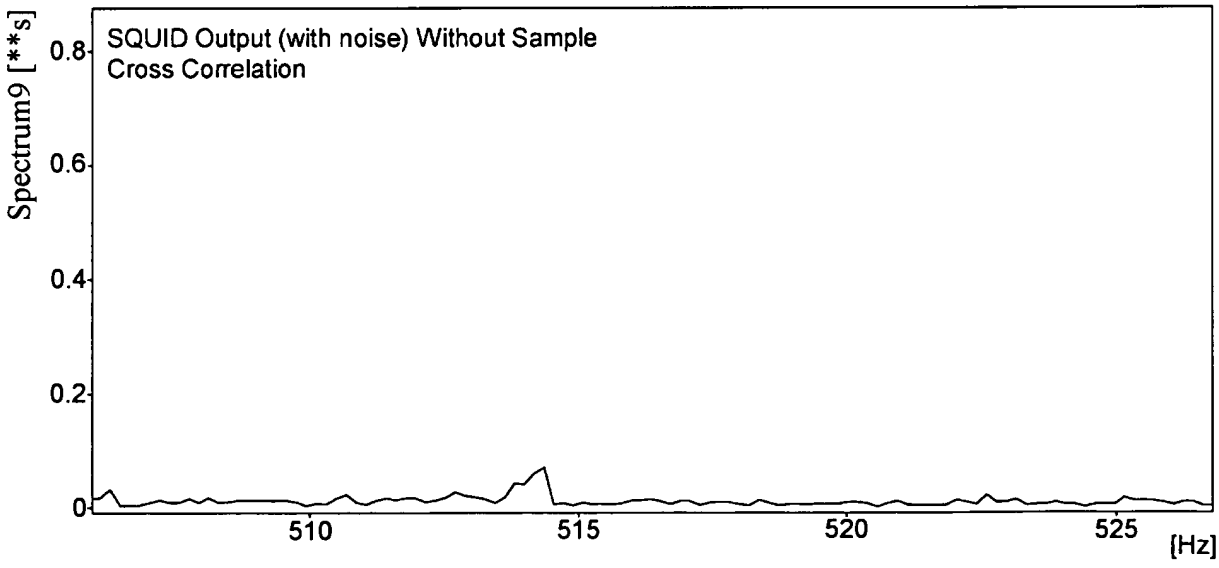


FIG. 14F

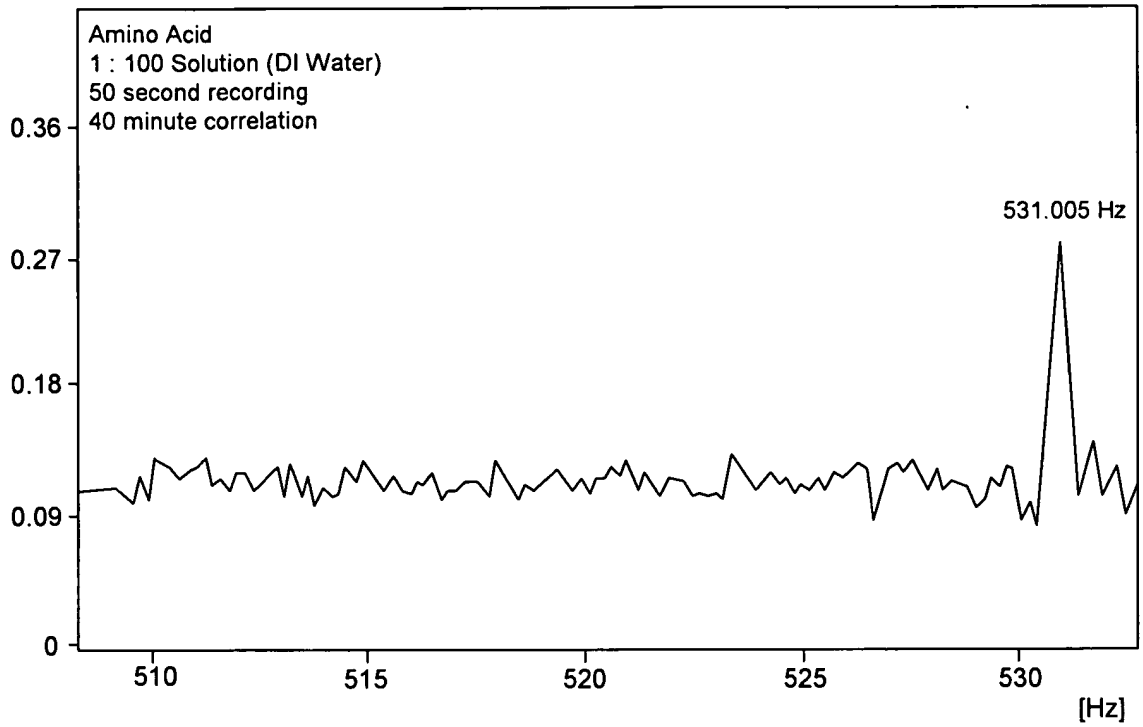


FIG. 15A

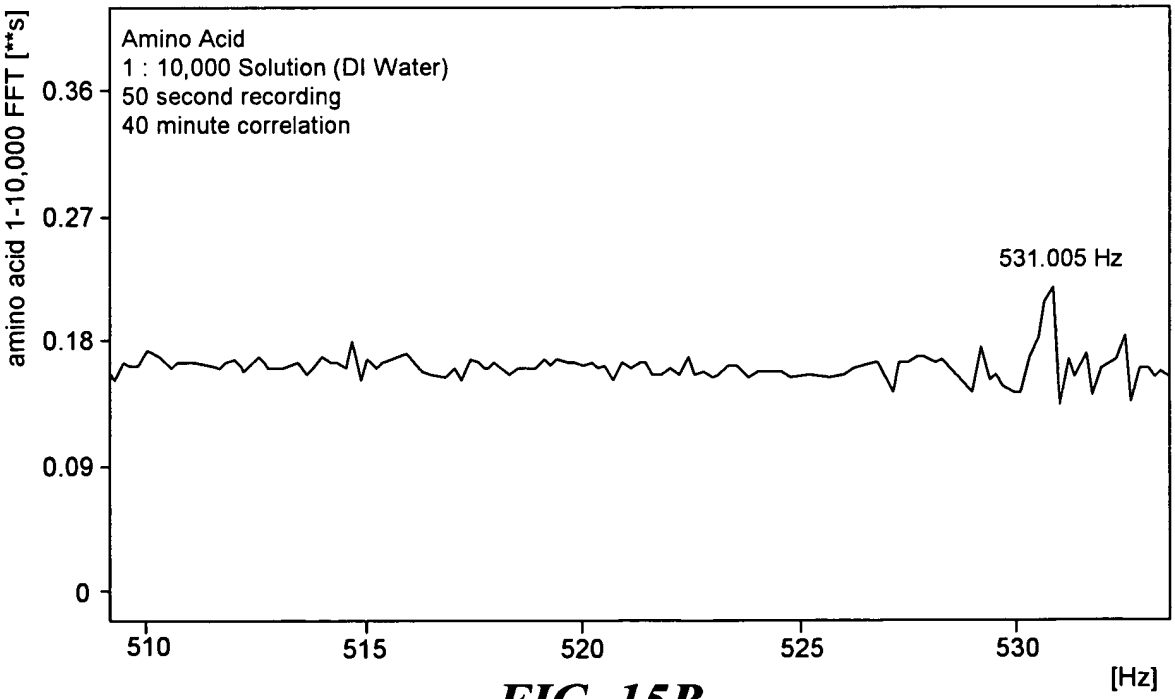


FIG. 15B

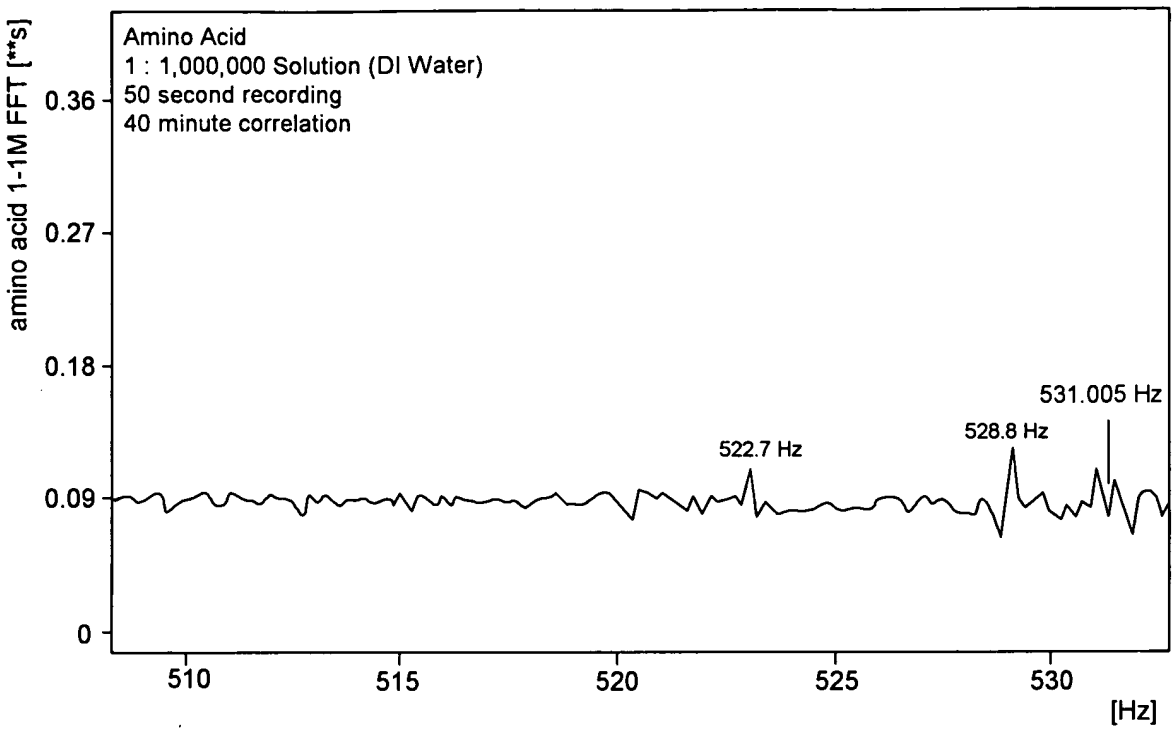


FIG. 15C

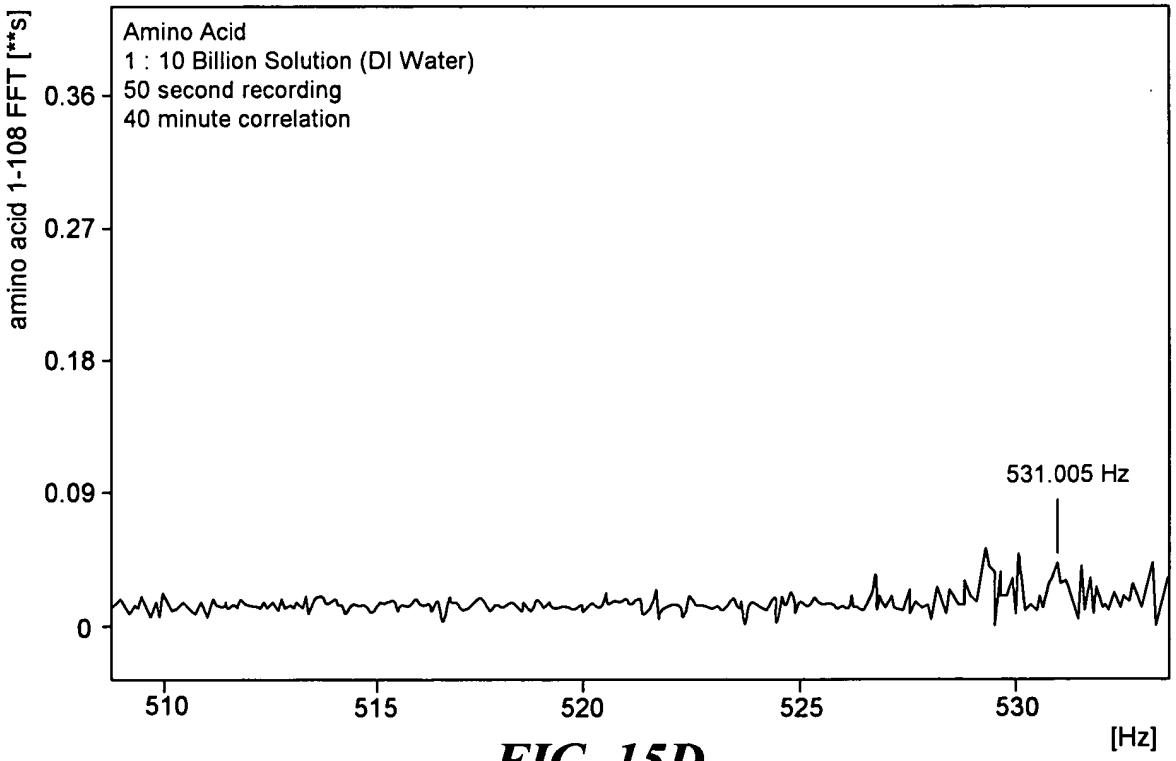


FIG. 15D

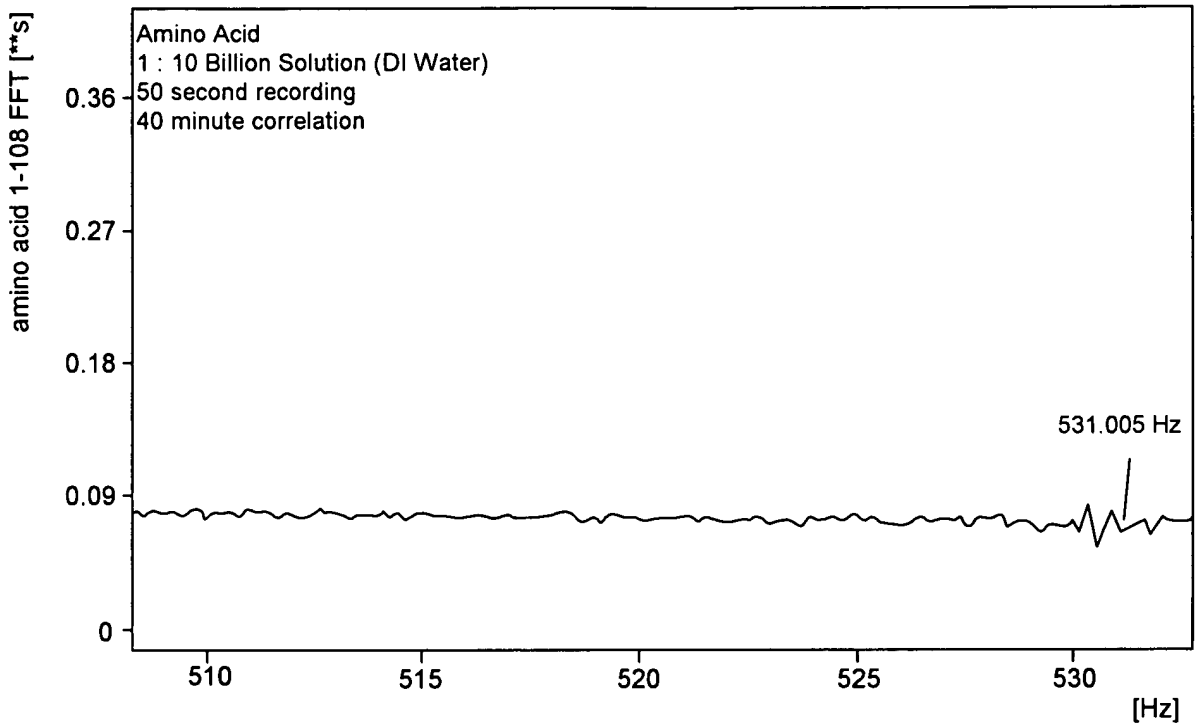


FIG. 15E

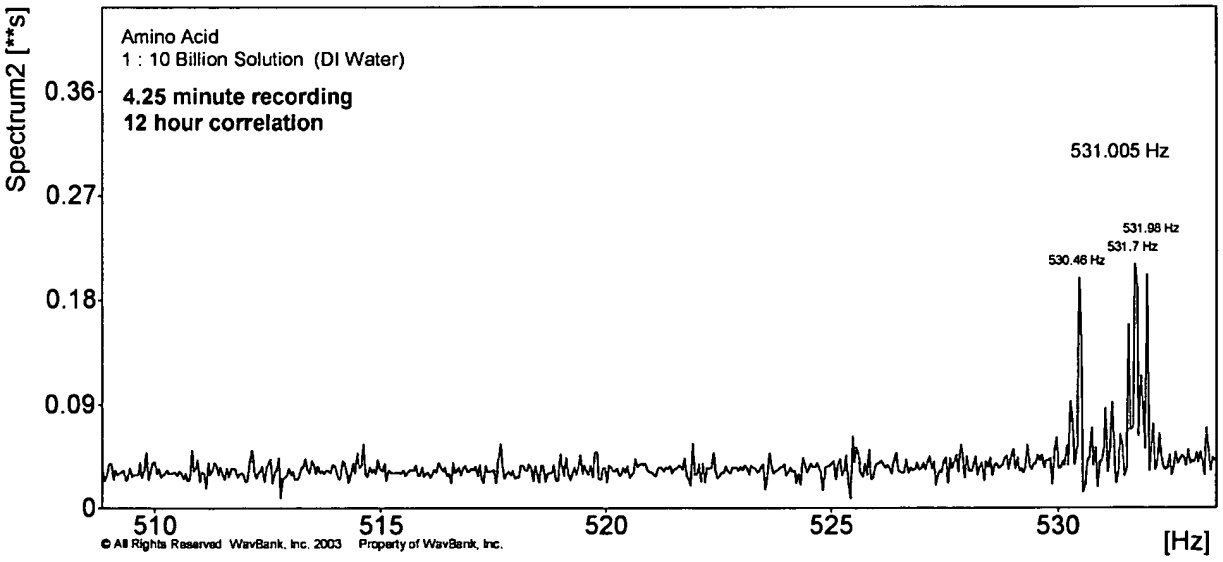


FIG. 15F

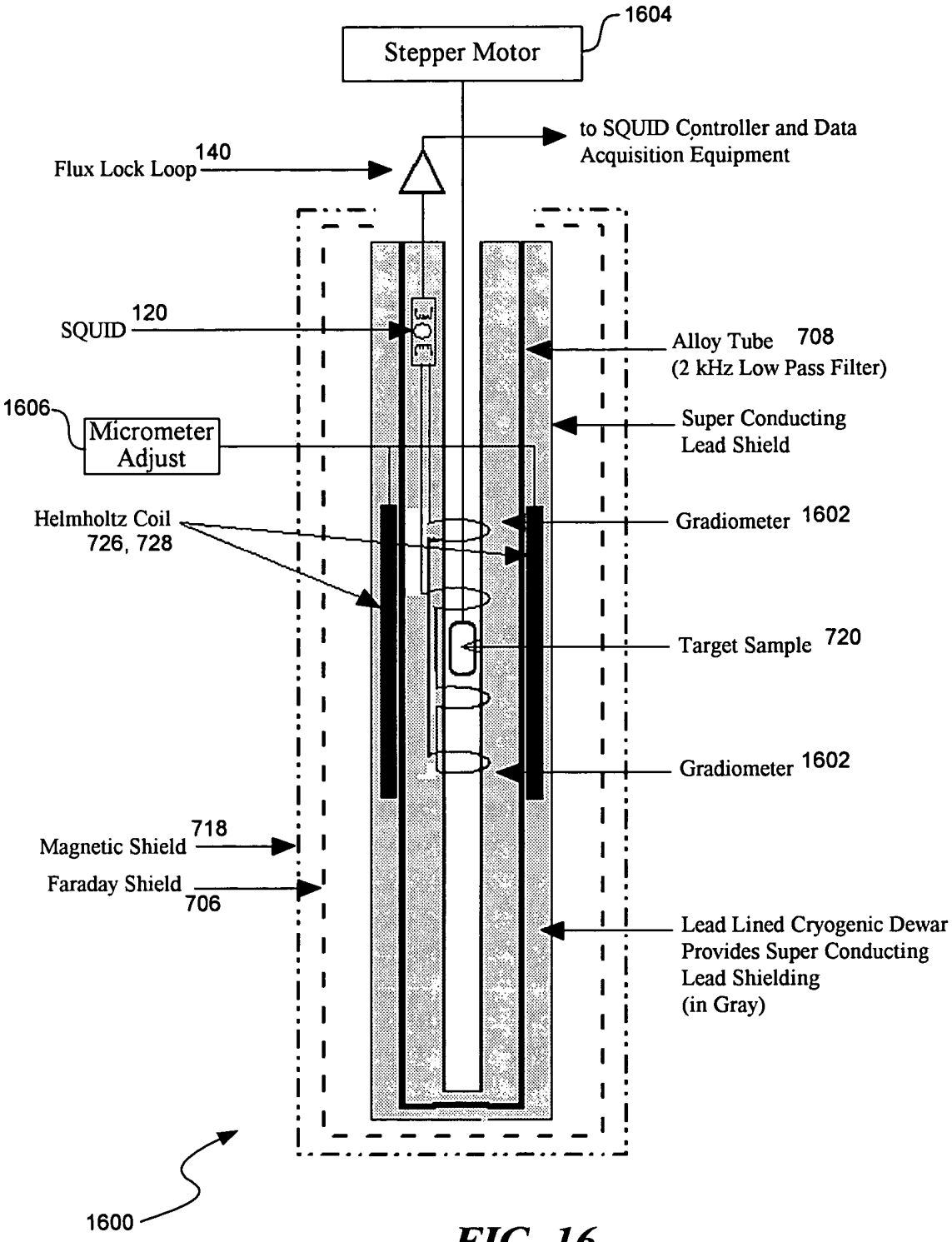

1604
Stepper Motor
to SQUID Controller and Data Acquisition Equipment
Flux Lock Loop 140
SQUID 120
Alloy Tube 708
(2 kHz Low Pass Filter)
1606
Micrometer Adjust
Super Conducting Lead Shield
Helmholtz Coil 726, 728
Gradiometer 1602
Target Sample 720
Gradiometer 1602
Magnetic Shield 718
Faraday Shield 706
Lead Lined Cryogenic Dewar Provides Super Conducting Lead Shielding (in Gray)
1600

FIG. 16

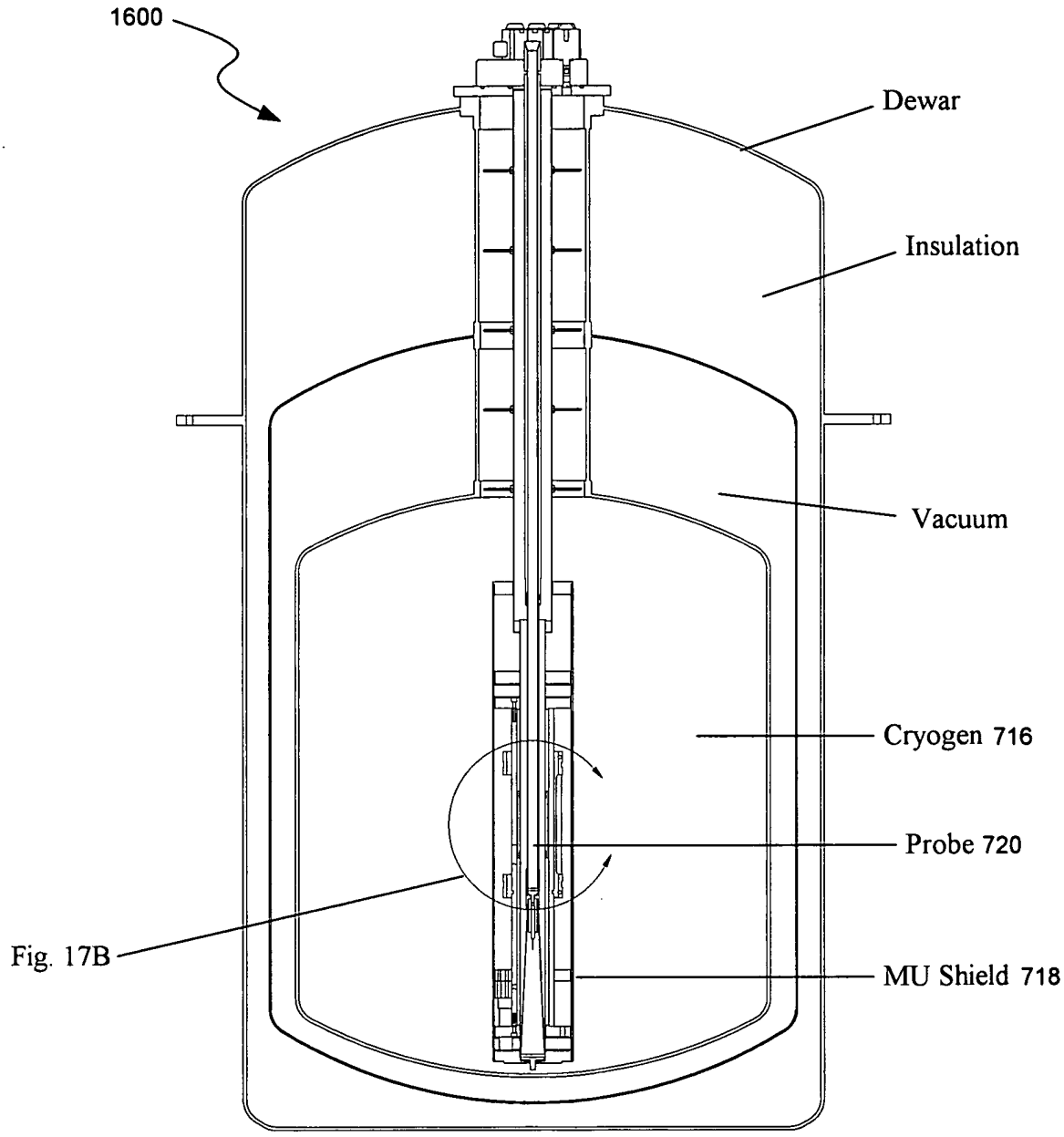

1600
Dewar
Insulation
Vacuum
Cryogen 716
Probe 720
Fig. 17B
MU Shield 718

FIG. 17A

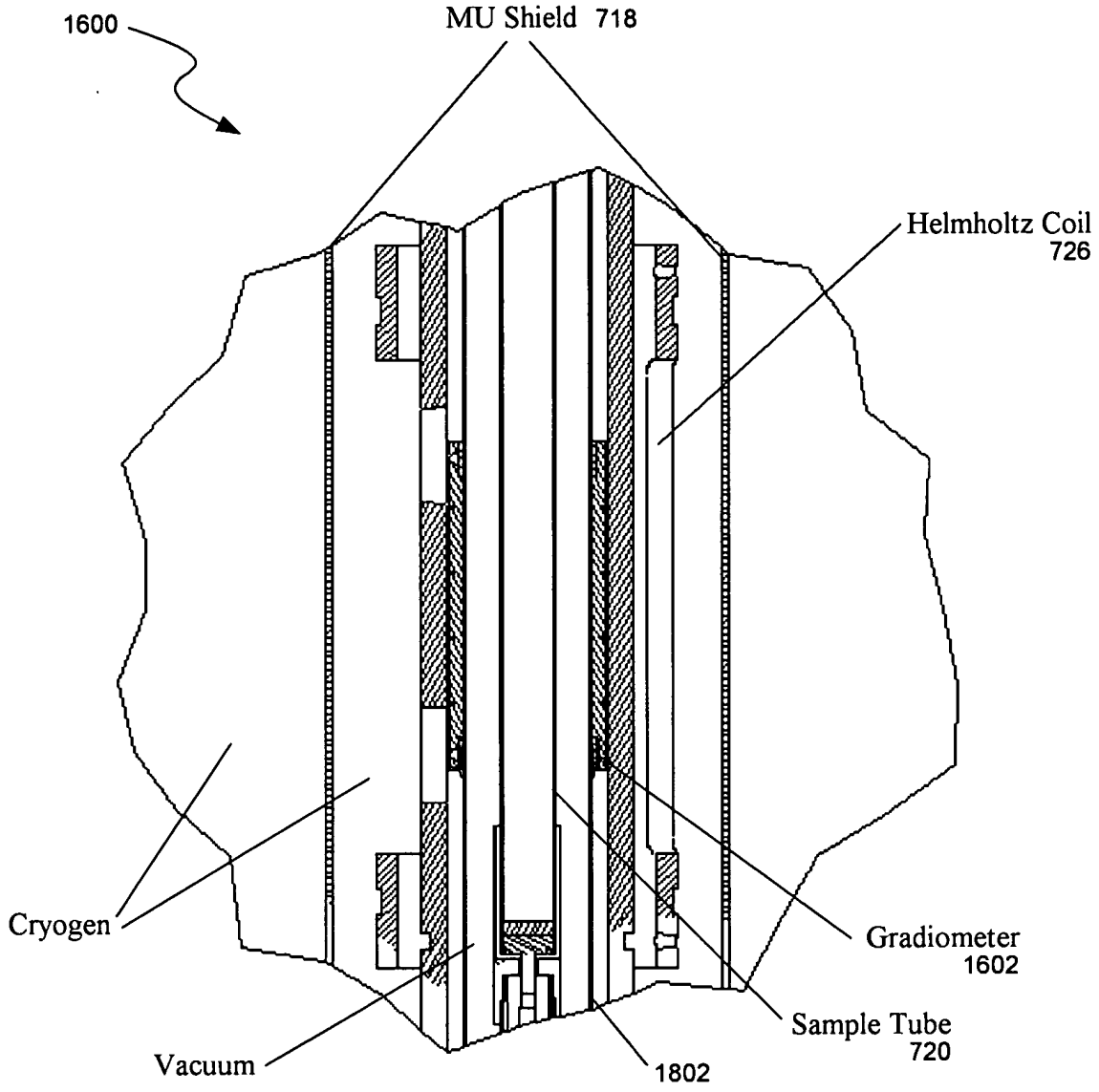

1600
MU Shield 718
Helmholtz Coil
726
Cryogen
Gradiometer
1602
Sample Tube
720
Vacuum
1802

FIG. 17B

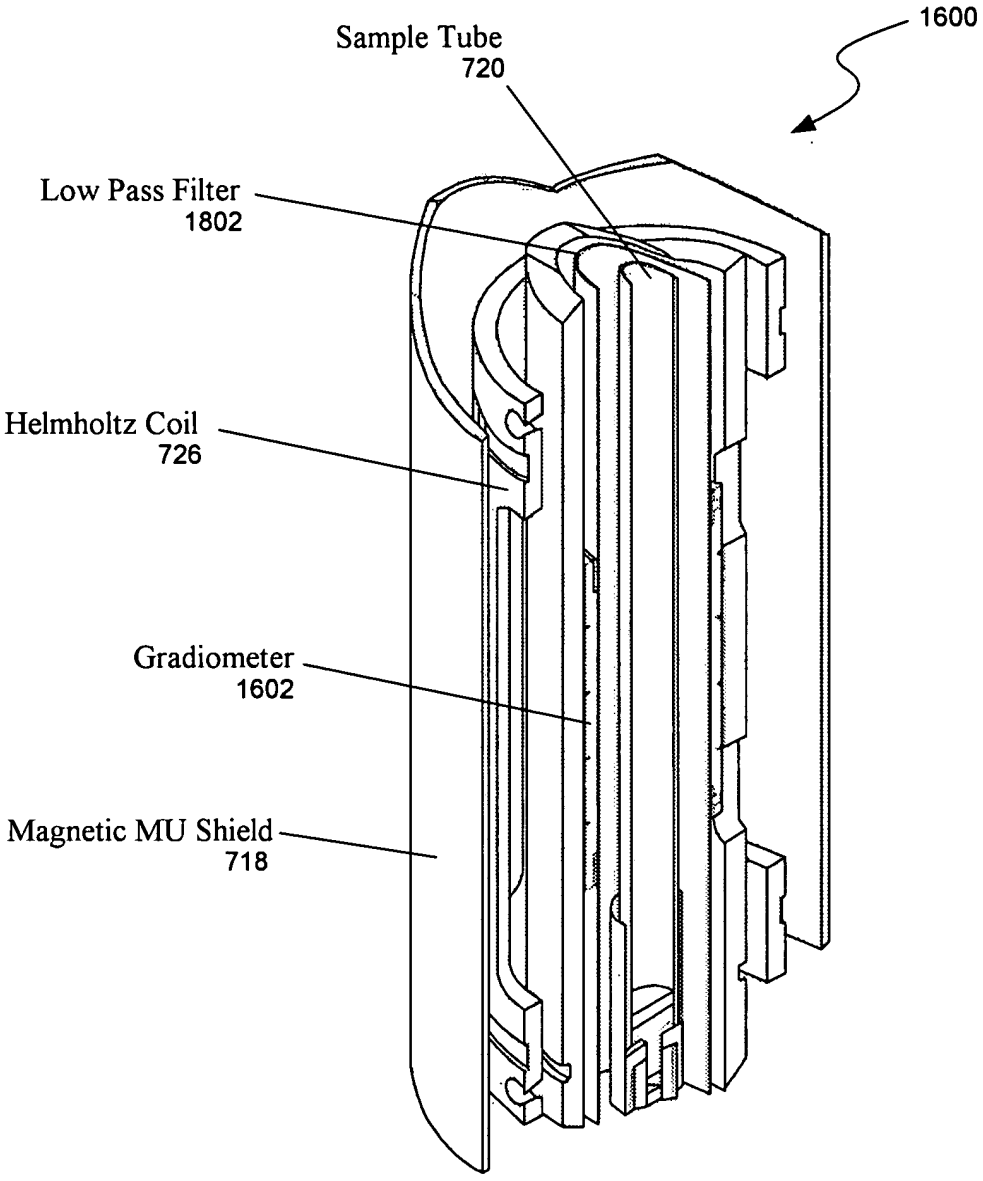

1600
Sample Tube
720
Low Pass Filter
1802
Helmholtz Coil
726
Gradiometer
1602
Magnetic MU Shield
718

FIG. 18

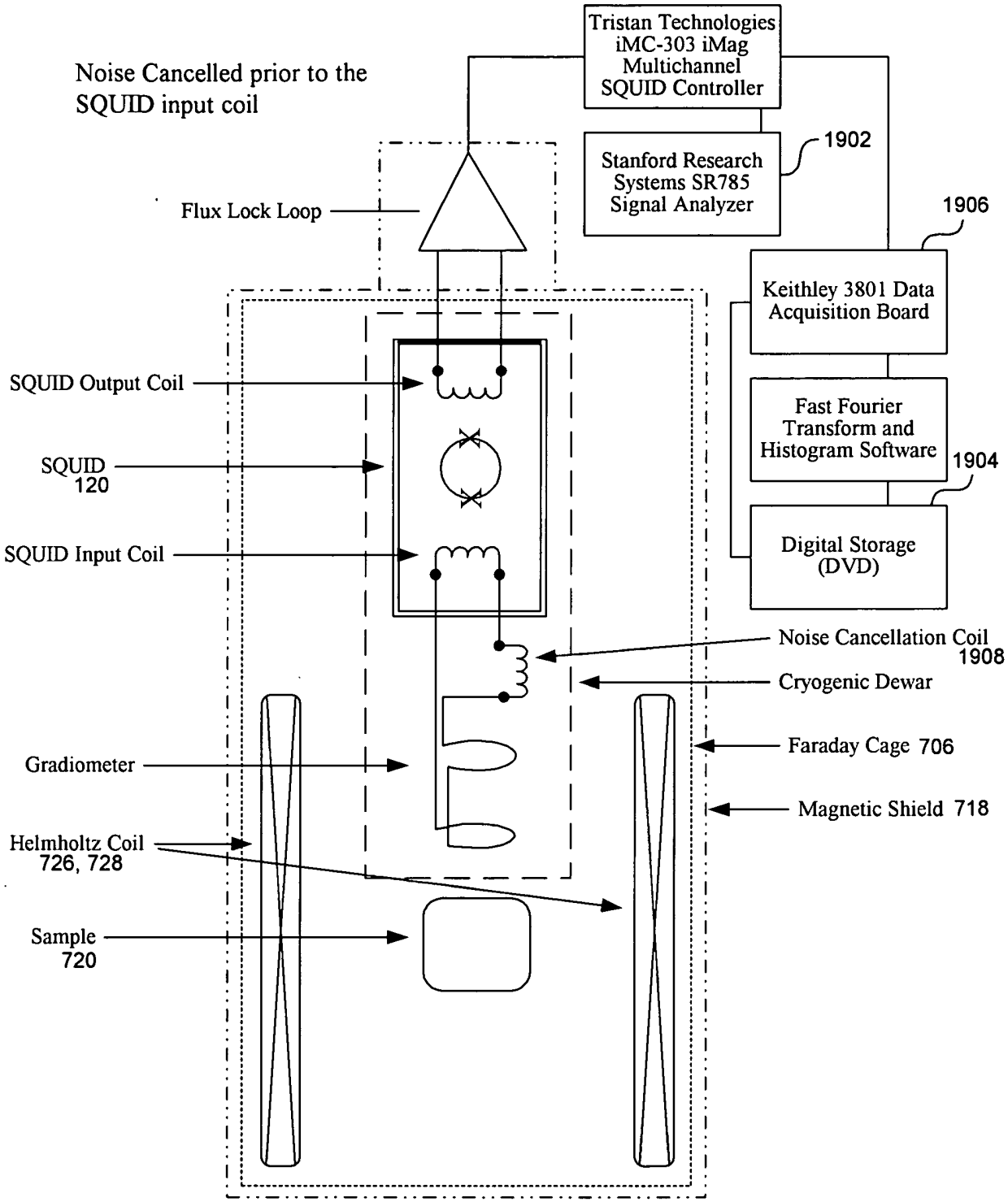

Noise Cancelled prior to the SQUID input coil
Tristan Technologies iMC-303 iMag Multichannel SQUID Controller
Stanford Research Systems SR785 Signal Analyzer
1902
1906
Keithley 3801 Data Acquisition Board
Fast Fourier Transform and Histogram Software
1904
Digital Storage (DVD)
Flux Lock Loop
SQUID Output Coil
SQUID 120
SQUID Input Coil
Noise Cancellation Coil 1908
Cryogenic Dewar
Faraday Cage 706
Magnetic Shield 718
Gradiometer
Helmholtz Coil 726, 728
Sample 720

FIG. 19

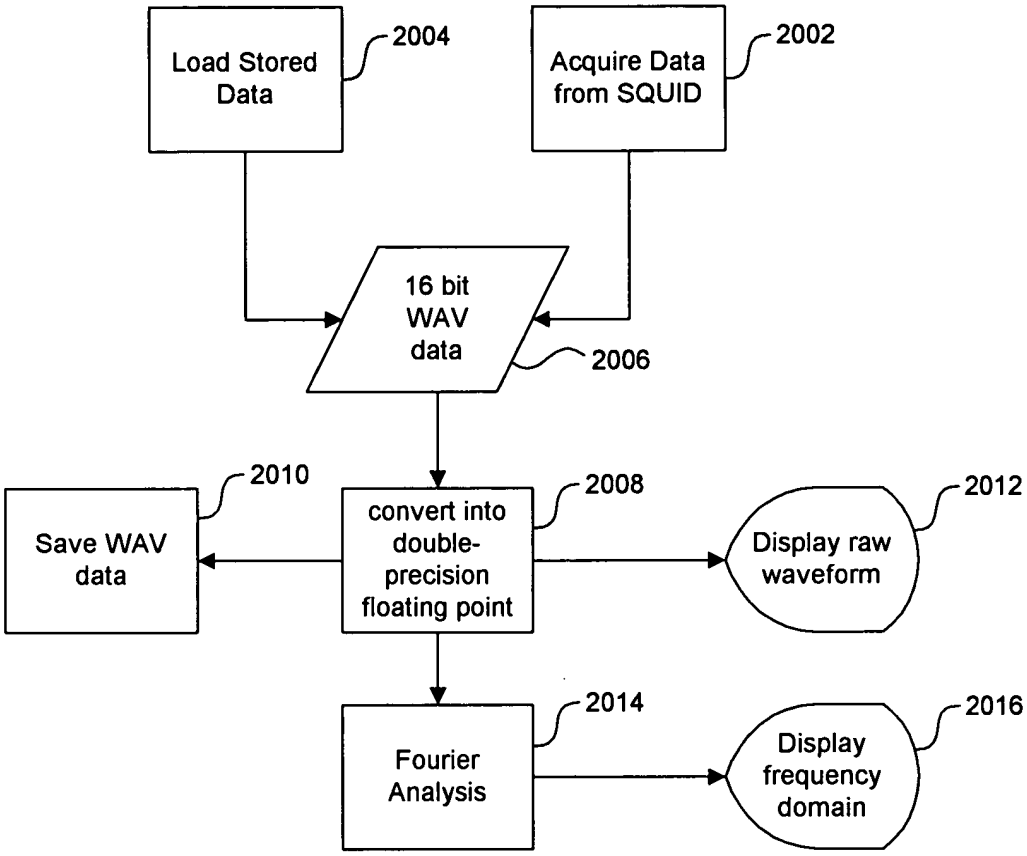

Load Stored Data
2004
Acquire Data from SQUID
2002
16 bit WAV data
2006
Save WAV data
2010
convert into double-precision floating point
2008
Display raw waveform
2012
Fourier Analysis
2014
Display frequency domain
2016

FIG. 20

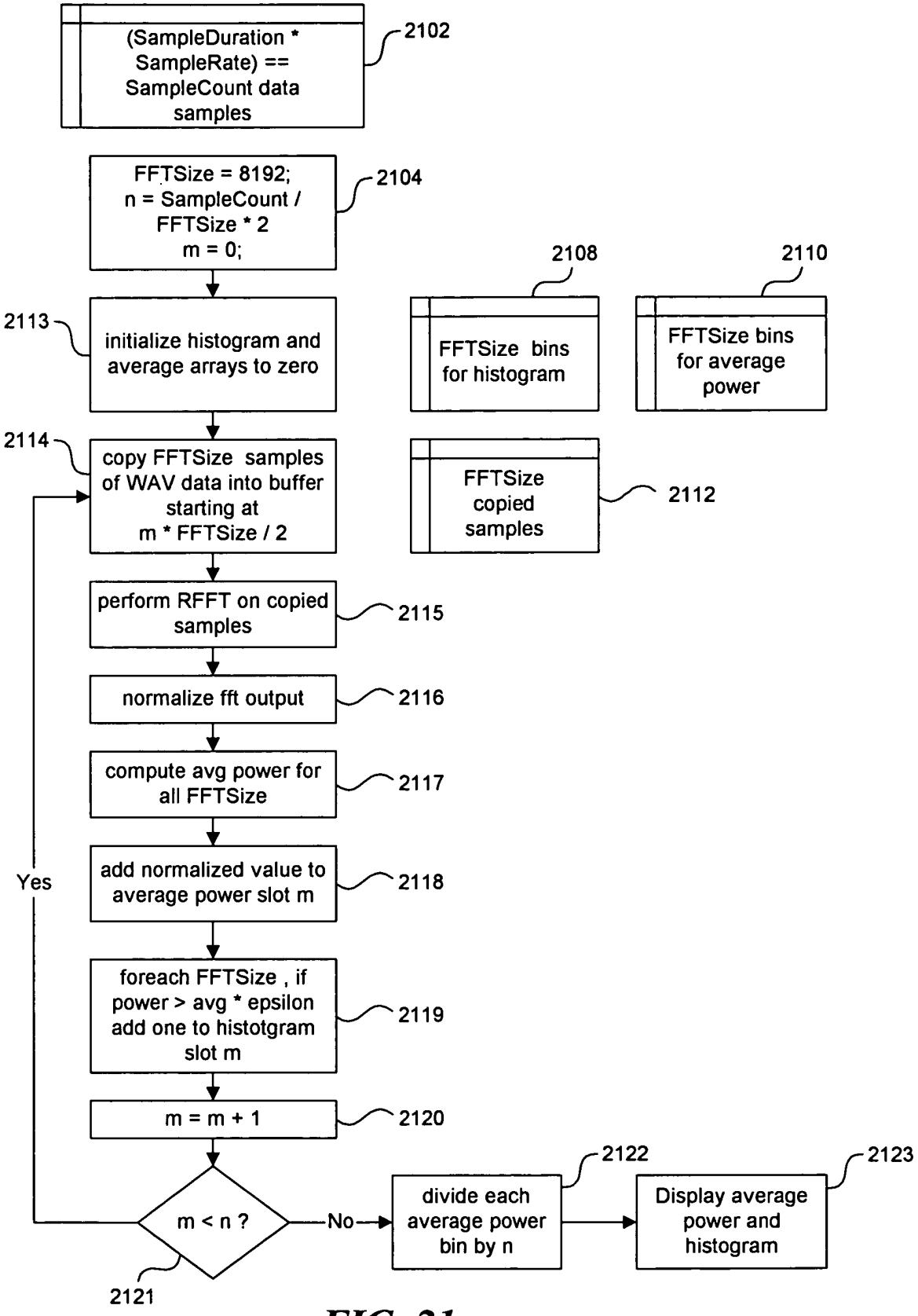
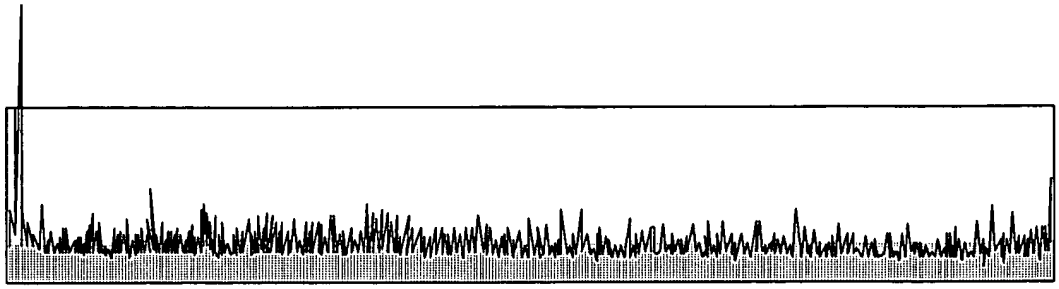
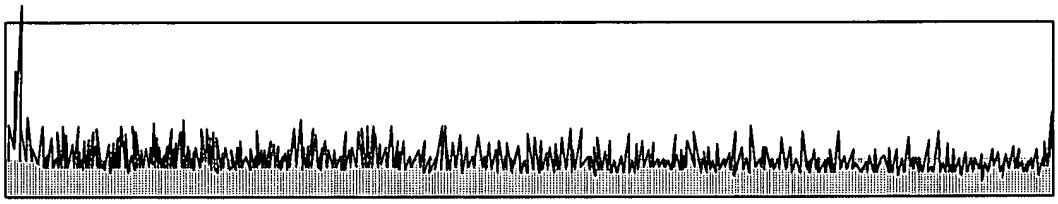

(SampleDuration * SampleRate) == SampleCount data samples
2102
FFTSize = 8192;
n = SampleCount / FFTSize * 2
m = 0;
2104
2108
FFTSize bins for histogram
2110
FFTSize bins for average power
2113
initialize histogram and average arrays to zero
2114
copy FFTSize samples of WAV data into buffer starting at m * FFTSize / 2
FFTSize copied samples
2112
perform RFFT on copied samples
2115
normalize fft output
2116
compute avg power for all FFTSize
2117
add normalized value to average power slot m
2118
Yes
foreach FFTSize , if power > avg * epsilon add one to histotgram slot m
2119
m = m + 1
2120
m < n ?
2121
No
divide each average power bin by n
2122
Display average power and histogram
2123

FIG. 21



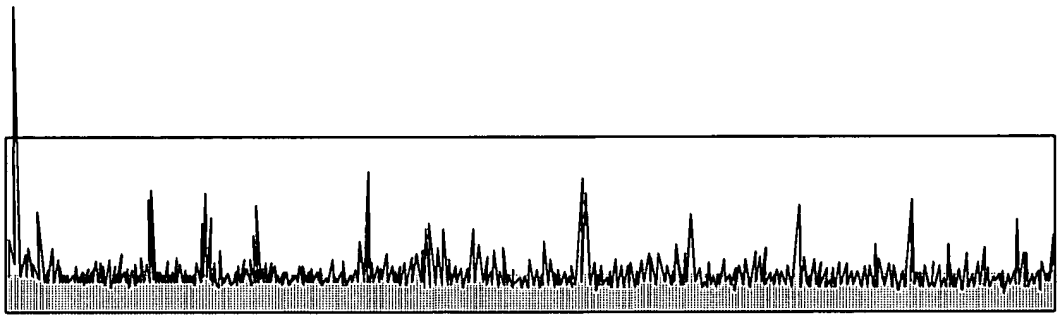
400 mV noise signal applied. No stochastic event visible.

FIG. 22A



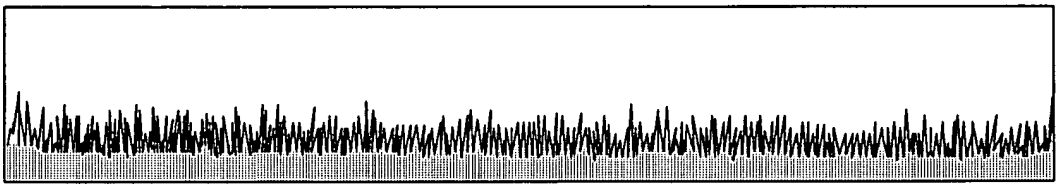
600 mV noise signal applied. No stochastic event visible.

FIG. 22B



700 mV noise signal applied. Stochastic event visible.

FIG. 22C



900 mV noise signal applied. No stochastic event visible.

FIG. 22D

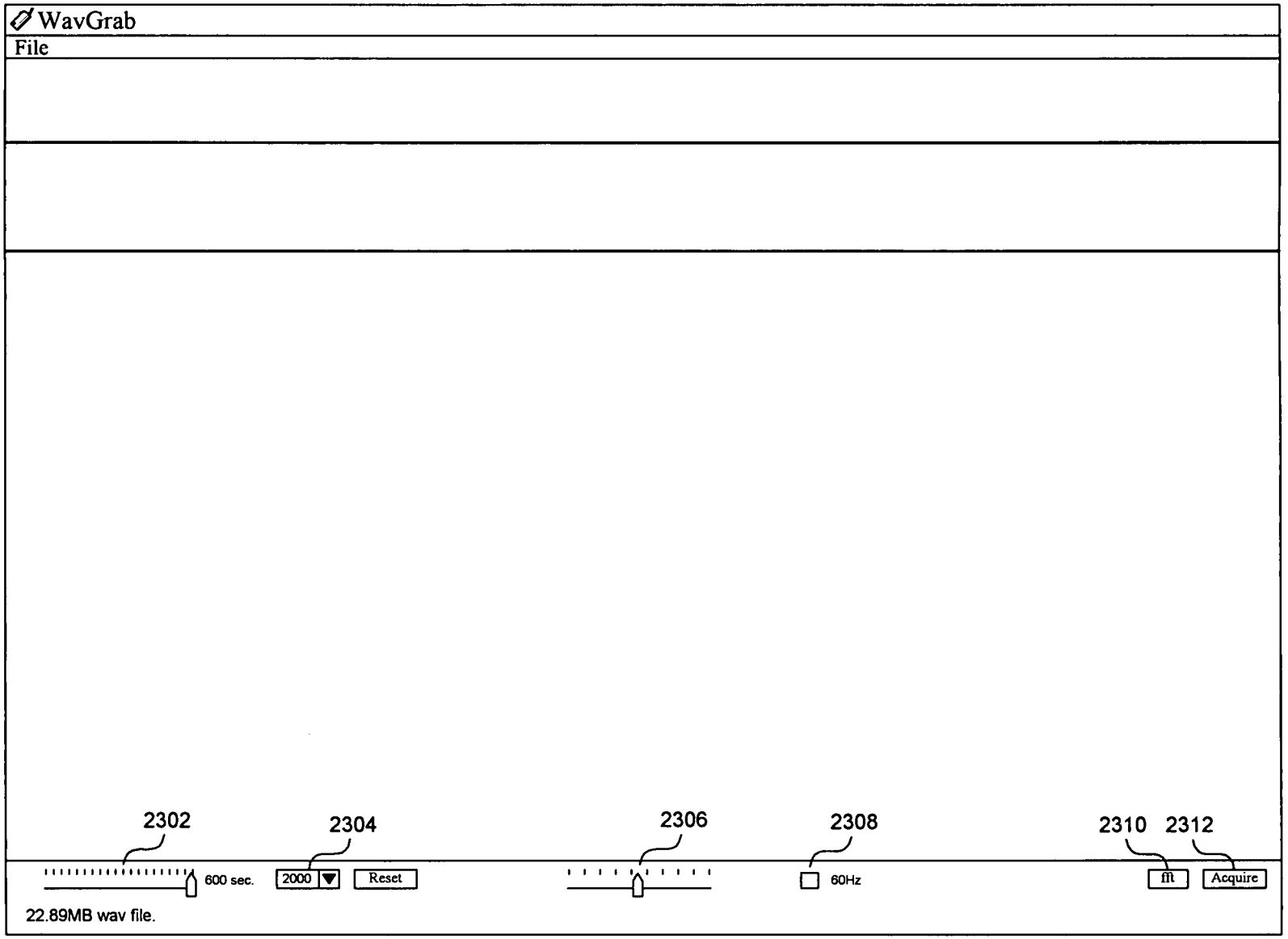

WavGrab
File
2302
2304
2306
2308
2310
2312
600 sec.
2000
Reset
60Hz
fft
Acquire
22.89MB wav file.

FIG. 23A

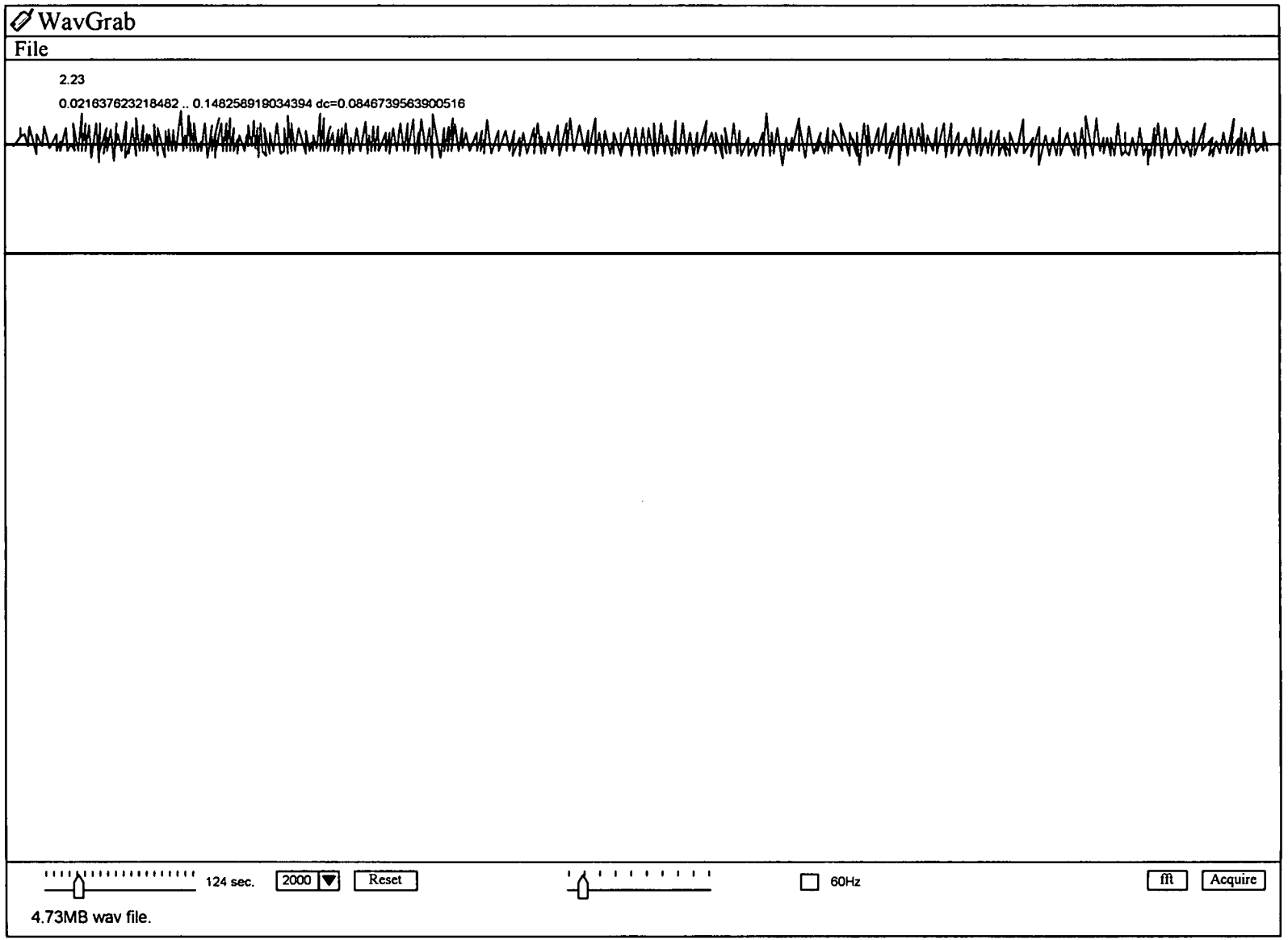

WavGrab
File
2.23
0.021637623218482 .. 0.148258919034394 dc=0.0846739563900516
124 sec.
2000
Reset
60Hz
fft
Acquire
4.73MB wav file.

FIG. 23B

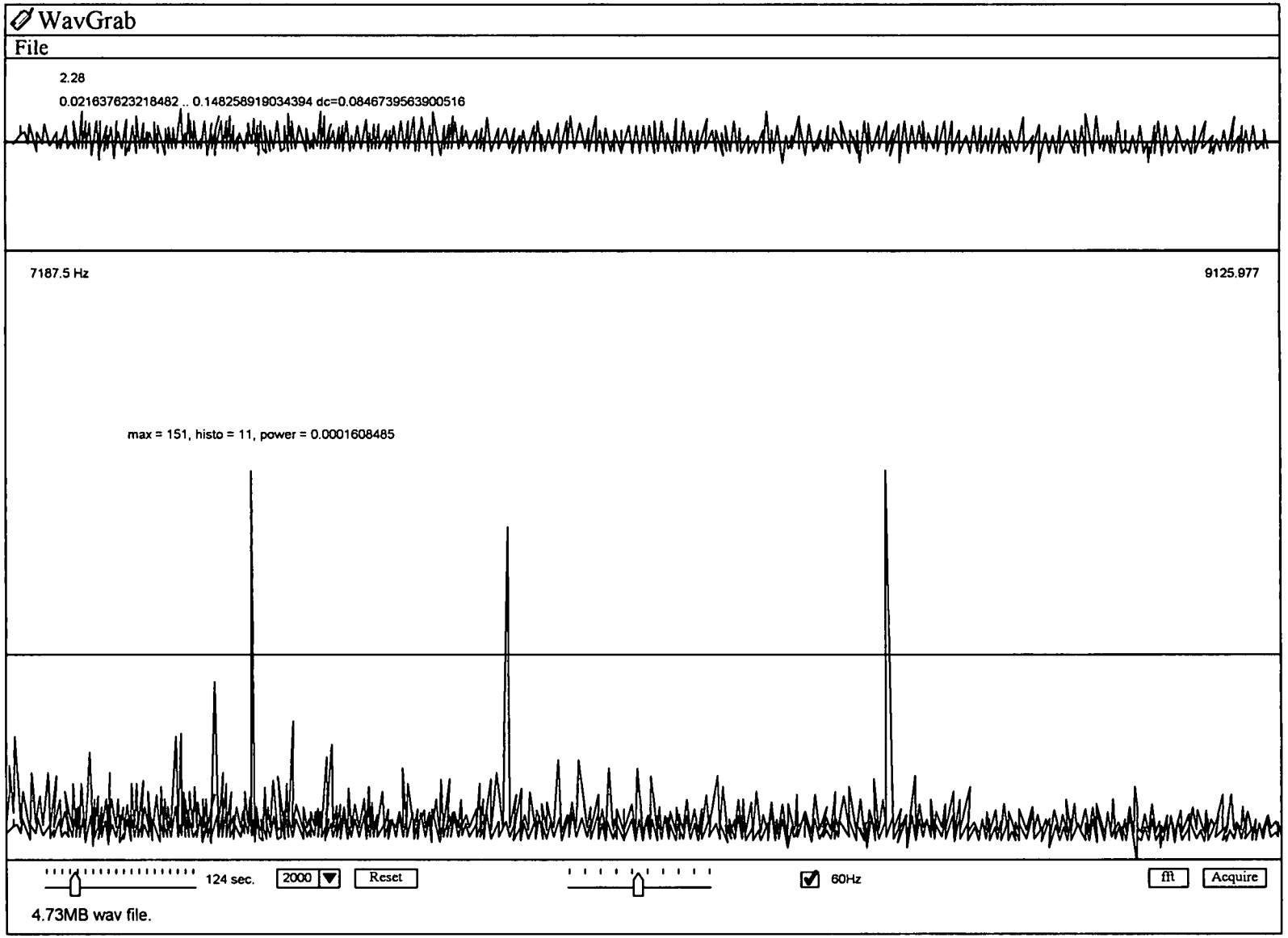

WavGrab
File
2.28
0.021637623218482 .. 0.148258919034394 dc=0.0846739563900516
7187.5 Hz
9125.977
max = 151, histo = 11, power = 0.0001608485
124 sec.
2000
Reset
60Hz
fft
Acquire
4.73MB wav file.

FIG. 23C